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GAPS IN OUR KNOWLEDGE OF HYDATID DISEASE:
A PLEA FOR FURTHER RESEARCH AND A TRIBUTE TO PROFESSOR FÉLIX DÉVÉ, OF ROUEN.

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As is well known, that tiny tapeworm, the *Tænia echinococcus,* which in the adult stage is an intestinal parasite of the dog, spends its cystic life, and a long and eventful life it may be, in the bodies of other animals, notably sheep and cattle and human beings. Thus is produced what we call hydatid disease, a malady which has so many known features of unusual interest, and which presents so many alluring problems yet to be solved by the biologist, and the pathologist, the hygienist, and the veterinarian, the physician and surgeon, that it can justly be regarded as the most fascinating subject for research work in all parasitology.

The only English-speaking countries where hydatid disease is at all common are Australia and New Zealand, and although the names of Davies Thomas, Graham, Lendon, Verco, Stirling, MacLaurin, Hamilton Russell, the Fairleys, Dew, Kellaway, Clunies Ross, Welsh, Chapman, Barling, Miss F. E. Williams, Hercus, Watson, Bird, Cleland, MacCormick, and numerous clinicians are widely known for their researches and writings on this subject, work that has without doubt usefully supplemented the epoch-making contributions of noted European and South American investigators, much still remains to be done, especially in the field of animal experimentation. Australia and New Zealand should surely take a larger share in the task of acquiring and distributing hydatid knowledge, not only in the cause of scientific progress, but for the direct benefit of human welfare.

HYDATID REGISTRY.

Seeing that hydatid disease is of special concern to surgeons, it is fitting that the Royal Australasian College of Surgeons should encourage hydatid research in every possible way, and already it has made a

beginning in that direction. A Hydatid Registry has been established for the collective investigation of clinical cases, and it is hoped that, within a few years, at least 1,000 records will be available for analysis.

The idea originated in New Zealand, and the present committee consists of Sir Hugh Acland (Christchurch), Professor Gordon Bell (Dunedin), with Sir Louis Barnett (Hampden) as Chairman, and Dr. Roland Fulton (2 Pitt Street, Dunedin) as Registrar.

Fellows of the College are earnestly asked to support this effort at collective clinical research, and to send their hydatid records to Dr. Fulton, who will on request supply the appropriate case-taking forms to any practitioner.

In addition, it is anticipated that hydatid disease will figure prominently in the experimental research work that will be instituted in the College laboratories just as soon as finances permit.

RESEARCH IN DIAGNOSIS.

Until a few years ago the diagnosis of hydatid disease, which was then based on the ordinary clinical examination supplemented by X ray investigation, proved faulty in more than half the cases. Now, with modern laboratory aids, particularly the complement fixation test and the Casoni skin reaction, diagnostic success has been increased to 80% or more.

But 80% is not perfection: laboratory aids, for various reasons, some of them known and some of them unknown, too often fail or deceive the clinician. The need for further laboratory researches, particularly in the realm of immunology, is clearly recognized, and in many parts of the world, including Australia and New Zealand, work on these lines is being actively pursued.

NON-OPERATIVE TREATMENT.

Here obviously is an important field for research.

The only effective method we have at the present time for dealing with hydatid cysts is by surgical operation, and if cysts are located in unapproachable or dangerous places, for example, certain cysts in the region of the brain, spinal cord, heart or pelvic bones, or if there are multiple secondary invasions of abdomen or thorax, operations are either out of the question or of dubious value.

Nature, unaided, sometimes expels cysts from the body and thus brings about spontaneous cure, as is often enough observed in the case of deep-seated lung hydatids, and occasionally in other parts of the body. Cysts also may die within the body and become harmlessly encapsuled in a zone of dense fibrous tissue sometimes calcified. Cysts of considerable size may undergo this quiet death and burial, and in the case of multiple broadcast dissemination of scolices following rupture of a fertile cyst it is quite common to find evidence of abortion, involution and encapsulation of numbers of minute cysts in the early states of their development. A good example of this process is the *pseudotuberculose hydatique* described by Dévé.

Can we not do something effective to supplement the immunizing and self-healing powers Nature possesses, or, failing that, to destroy by some harmless procedure the parasite cysts *in situ*?

Numerous recorded efforts have already been made in this direction by the administration, local or general, of drugs and other substances, such as corrosive sublimate, formalin, ether, antimony, iodides and lipiodol, arsenobenzol, "Neosalvarsan", "Rivanol", extract of male fern and kamala, by the injection of serum and of vaccine, and by the exposure of the cysts to the influence of X rays, or radium, or diathermy, but all so far without proved success. The renowned hydatidologist, Dévé, who has given close attention to this alluring line of investigation, and who has experimentally tried out most of these alleged cures, has been regretfully forced to the conclusion that they are all illusory.

OPERATIVE TREATMENT.

The operative treatment of hydatid cysts is now fairly well standardized, but a careful analysis of a large number of recorded cases would help to remove doubts and disagreements regarding such matters as the best and safest approach to deep-seated cysts, the two-stage operation, the most effective technique for evacuating multivesicular cysts, the question of drainage or no drainage, the best methods for dealing with long bones riddled by cysts and so on.

PREVENTIVE TREATMENT.

In regard to prevention, certain unsolved problems are of intense importance from the economic, as well as the health, point of view. In Australia and New Zealand, in Argentine and Uruguay, and in many other countries where hydatid disease is particularly frequent, a considerable number of human beings are annually infected and later incapacitated and perhaps lose their lives, and a very high percentage of the lungs and livers of animals killed at abattoirs for food purposes have to be condemned.

These are serious happenings, and if we are to prevent their occurrence, we must break the well-known vicious circle of infection from the tapeworm ova of the dog to the scolex-bearing cysts of sheep and back again to the dog; for the sheep is *par excellence* the host of the cystic stage, as the dog is of the adult parasite, and human infestation, though in minor degree, is always proportionate to that found in sheep.

Assuming that a dog is, to begin with, free from hydatid infection or has been freed by the administration of "Arecolin hydrobromide" or other vermifuge, how is it to be kept free? The obvious answer is: "Do not feed the dog on raw offal, seeing that this material so often, more often than not, indeed, in our countries, contains hydatid cysts." Now this rule seems simple enough, but talk to a farmer and he will tell you it is impracticable. Dogs' "tucker" (food) must be provided with the minimum of trouble and expense, and the raw liver and lungs of killed sheep best fulfil these conditions. Out in the country the shepherds

and musterers will not bother about boiling or partly incinerating or disinfecting the viscera before throwing them to the dogs, nor will they bother to bring back these raw viscera to the homestead or camp so that they can be dealt with there. How are we going to get over these "too much bother" arguments? Education alone will not suffice. The scolices within the cysts are the active agents in producing the tapeworm in the dog and the problem yet to be solved is how to render these scolices innocuous to dogs, using a method that would appeal to a farmer as being simple, practical and inexpensive.

Then, again, how is the transfer of ova from the fæces of infected dogs to the mouths of sheep to be prevented?

The usual recommendations are: (i) Administer vermifuge medicine at periodic intervals to country dogs; and (ii) sterilize their fæces by boiling water or by incineration. Effective methods of enforcing these recommendations have yet to be devised.

An obvious inference in this connexion, which seems to have escaped notice hitherto, is that the ground in close proximity to those places where sheep dogs are chained up or kennelled for the night must be badly contaminated, while the more distant pastures must be comparatively free from pollution. I venture to suggest, therefore, that the important danger zone is the immediate environment of the sheep-farmer's homestead, and that hydatid infection of sheep usually takes place during the periodic rounding up or assembly of these animals for various purposes five or six times a year in the homestead yards and paddocks.

Various modes of transference of the ova from dog to man, and to the common herbivora, have been described, but these are for the most part ideas or probabilities only and are not yet definitely proved. For instance, the importance or non-importance of the rôles played by *les mains sales* (Dévé) ; inhaled fæcal dust (Dougan Bird) ; polluted water; contaminated vegetation, such as water-cress and other salads that are eaten raw; insects, particularly blue-bottles, and so on, should be submitted to scientific investigation and the whole subject put in its proper perspective.

At the Otago Medical School the Professor of Public Health, Dr. C. E. Hercus, has organized from the senior students a team of willing workers who study and report on the hygienic conditions of farms and sheep stations in the neighbourhood of their homes, paying particular attention to the subject of hydatid disease, its prevalence, dissemination and prevention.

BIOLOGY.

The Hatching of Ova.

The hatching of the ova requires further elucidation. How, when and where hatching occurs are all questions not yet definitely settled. The old teaching, for instance, that the chitinous envelope or egg-shell has to be dissolved by gastric juice before the contained hexacanth

embryo can be liberated, has been shown by Dévé (1904 and 1907), and since then by other investigators, to be erroneous. Personal observations I have made at the Otago Medical School in collaboration with Dr. C. M. Hector support Dévé's views and indicate that warmth, moisture and a mildly alkaline medium favour hatching, but that the envelope is not dissolved; it simply breaks open like a hen's egg when the embryo is sufficiently evolved to express its urge for liberation. Even gentle manipulation under a cover glass sometimes breaks open the shell.

The Hexacanth Embryo.

Our knowledge of the hexacanth embryo stage of echinococcic life is very defective. We do not know, for instance, in what part of the alimentary tract the embryo is liberated from its shell, nor how it attaches itself to the mucous membrane, nor how it gets to its final destination. We do not know how it is transported from the surface into the lumen of a blood or lymph vessel. Does it burrow by the action of its six curved spiny appendages (as Van Beneden suggested) or do these hooked processes serve merely for anchorage purposes; and is transport effected by amœboid action, as in the case of the *Entamœba histolytica* of dysentery?

Does the selected lodgement of the embryo in the capillaries of the liver, the lung or elsewhere depend on anatomical peculiarities or on biological affinity? Why, in some animals, for example cattle, and notably the squirrel, as pointed out by Dévé, is the lung much more often the site of hydatid cysts than the liver; and why, for example, does an allied organism, the *Cœnurus cerebralis,* choose the brain for its home in the cystic stage?

Dew tells of having discovered the hexacanth embryo in the portal vein of a sucking pig killed only eight hours after being fed with hydatid ova, but how it got there remains so far pure conjecture.

Tissue culture experiments should throw light on this mystery. The behaviour of hydatid ova in contact with fragments of intestinal mucous membrane could quite well be studied, and it might even be found possible to illustrate the activities of the hexacanth embryo by means of a cinema film.

Hydatid Cysts.

Hydatid cysts, those beautiful and mysterious objects, have already received much attention from biologists, pathologists, radiologists and clinicians, but there is still much to learn about them.

The typical cyst is univesicular, contains clear watery fluid, and is fertile by reason of the development from the endocyst of those intensely interesting and important bodies, the scolices.

A feature that has not yet been studied is the high tension of hydatid fluid in this type of cyst, which presumably keeps the mother membranes in contact with the encircling adventitia. Could this tension or intracystic pressure not be measured? It is, I suggest, of vital importance to the parasite and to its host, for a lowering of the tension

profoundly alters both biological evolution and clinical manifestations. If a cyst is injured, for example if the ectocyst, which is very fragile, is fissured accidentally or penetrated by surgical puncture or incision, a reduction in tension takes place and the mother membranes fall away more or less from the adventitia—osmosis or dialysis is altered, the vitality of the whole cyst is menaced, a reproductive urge is set in action and scolices become evolved into daughter cysts, which may, for reasons not yet explained, develop either endogenously or exogenously or intra-cuticularly. Most of what we know about scolices is due to the work of Dévé, and he tells us how much there is still to learn, and appeals to other research workers to join in experimental investigation. Dévé's friend, Coutelen, is the only other worker at the present time who is devoting attention to the fascinating subject of scoliculture in artificial media.

Dévé's epoch-making demonstration in 1901 of the direct evolution of scolices into secondary cysts and of their subsequent behaviour under varying conditions was the result of his experimental inoculations of "hydatid sand" (brood capsules and scolices precipitated from the fluid of fertile cysts) into the cavities, tissues and organs of susceptible hosts, such as the guinea-pig, sucking-pig, rabbit *et cetera*.

FÉLIX DÉVÉ.

In the year 1926 I made a pilgrimage to Rouen for the purpose of seeing Félix Dévé, Professor of Medicine at the University there, and acclaimed throughout the world as the doyen of hydatid parasitologists. I found him a man full of friendliness and hospitality and information (in French) and, needless to say, enthusiastic on the subject of hydatid research. Ever since then I have kept in close touch with him and his work, and last year I received from him a copy of a paper-bound book entitled *"Trente-deux années d'étude de l'échinococcose"*, and embodying a series of fifteen lectures on this subject which he delivered by special invitation of the Medical Association of Argentina at Buenos Ayres in August, 1932. The book, I notice, is published by *"Las Ciencias", Librería y Casa, Editora de A. Guidi Buffarini*, Buenos Ayres, and deals in masterly fashion with many aspects of hydatid disease of deep and practical interest to all medical scientists.

Dévé, though living in a district where hydatid disease is not at all prevalent, has been given opportunity to study cases occurring not only in his own practice, but in that of his neighbouring colleagues, and has accumulated clinical records of over 200 cases personally observed. He has also let no chance escape him of studying pathological specimens of hydatid infestation found at *post mortem* examination of human beings or occurring in the bodies of sheep, cattle and other animals.

Dévé is, moreover, an exceptionally diligent reader, and there is very little in the whole world's literature on the *Tænia echinococcus* with which he is not familiar.

But, above all, he is a laboratory enthusiast, and for the past thirty-three years, beginning with his epoch-making demonstration of the nature of secondary echinococcosis, he has devoted his time and his talents to the scientific search for truth about hydatid disease, and the revealing of traditional errors by the methods of animal experimentation. He has already published some 260 papers and monographs illustrated by his own skilful drawings, and all dealing with the *Tænia echinococcus* and the multitudinous morbid conditions it produces, and these contributions to our knowledge are all founded on accurate observation, logical reasoning, and experimental verification.

Dévé, being a physician, does not himself operate on the human subject, but all the same his contributions to surgical progress in the treatment of hydatid cysts are of the highest importance and have been generally adopted in most parts of the world. To him we owe the technique of preliminary formalinization and other precautions against post-operative recurrences, and he even invented, in 1913, a very practical three-way trocar to facilitate the removal of the hydatid fluid and the subsequent flushing of the cyst cavity with the formalin solution. He has also made valuable suggestions regarding the treatment of deep-seated pulmonary cysts, of hepatic cysts opening into the larger bile ducts, and of multiple cysts of the abdomen, and he has also pointed out the difficulties and dangers of decortication, and the possibilities of dispensing with drainage after evacuation of the cyst contents.

The final lecture of the series I refer to emphasizes the importance of experimental research, pleads for its wider adoption, especially in hydatid countries, and enumerates and discusses the following wide range of hydatid problems that Dévé personally has not yet dealt with, at any rate not to his own full satisfaction, and which call more or less urgently for investigation and solution.

1. In addition to the dog, what other animals can act as hosts to the adult *Tænia echinococcus*? A certain amount of evidence exists inculpating numerous carnivorous creatures, the jackal, fox, wolf, hyena, puma, jaguar, cat, vultures, and other birds of prey, but, except in the case of the first named, convincing experimental proof is lacking.

2. What is the vital resistance of hydatid ova to hostile influences in nature, such as heat, cold, sunshine, desiccation, immersion in water *et cetera*? Dévé himself has made many useful experiments in this connexion and he very properly thinks they ought to be repeated and extended.

3. Are there other paths besides the alimentary canal by which hydatid ova can enter the body, for example, by the bronchial tubes as first suggested by Dougan Bird, or even through the broken skin?

4. Where, and under what conditions, is the hexacanth embryo liberated from the ovum, and how does it reach its final destination? (*Vide* previous remarks under heading "Biology".)

5. What is the explanation of the different seat of election for hydatid cysts in different animals? Is it a matter of anatomical structure or of "biological affinity"?

6. What exactly are the histogenetic changes associated with the development of primary and secondary cysts and their various complications? Dévé has done wonderful work in this connexion, and his conclusions have been recently brilliantly corroborated by Dew, but much still remains unrevealed. Scoliculture (or should one say scoliciculture?) *in vivo* and *in vitro* offers here a fertile field for research and, incidentally, might help to solve the vexed problem of the ætiology of alveolar hydatid cysts.

7. What can be done to raise the efficiency of those valuable diagnostic aids, the complement fixation blood test and the skin reaction of Casoni of Sassari, and to extend our limited knowledge of hydatid toxicity and immunity antigens and antibodies, anaphylaxis and spontaneous involution?

8. Is there no effective treatment for hydatid disease other than by operation? (*Vide* previous remarks under heading "Non-Operative Treatment".)

9. Is it not possible by experimental inoculation of hydatid fluid containing scolices into selected areas of the brain and spinal cord to obtain as a result of subsequent cyst formation all the effects of slow steady non-inflammatory pressure and thereby learn many new facts regarding neurological function and diagnosis? Dévé himself has already proved that this is practicable and expresses surprise that neurologists have not yet grasped the importance of his suggestion.

CONCLUSION.

Dévé, in one of his lectures, speaks of the remarkable shrinkage in the number of sheep reared on French farms since the war, a shrinkage which, combined with better hygienic prophylaxis and associated naturally with the employment of fewer sheep dogs, has led to a definite lessening of human infection as shown by hospital and personal records. He bewails the fact that this shrinkage has also reduced almost to vanishing point in his own district of Normandy the opportunities of obtaining abattoir material for hydatid research, and he covets the rich resources still available in South America and in Australasia.

There is reason to believe that in all the so-called hydatid countries (Iceland is a notable example) human infection is becoming less frequent, but sheep seem to be as commonly affected as ever (at any rate in New Zealand) and facilities for hydatid research with us are always easily obtainable. Let us therefore be up and doing. There is promise of a rich harvest for the cultivators of the field of hydatid experimentation.

THE RADIUM THERAPY OF CARCINOMA OF THE CERVIX UTERI: NOTES ON THE IMMEDIATE RESULTS OF TREATMENT.

By Eugene Lynch,

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THE present communication is based upon a consecutive series of seventy cases of cancer of the *cervix uteri* which have been reviewed by the Cancer Treatment Centre of the Wellington Hospital during a period of four years, ending in September, 1933.

Only the immediate results of treatment are at present under consideration, and none of the cases is eligible for classification on a five-year survival basis. It is felt, however, that a good deal of useful information can be gained from a study of material in which treatment has been more recent.

In fifty-two cases the clinical diagnosis has been confirmed by histological means. Two of these are adeno-carcinomata arising in the cervix and the rest are of the squamous cell type. No attempt has been made to grade them, for it is well known that an examination of the small specimen secured by biopsy may fail to represent accurately the histological nature of the tumour as a whole.

In the eighteen cases in which micro-pathological data are lacking all the patients came under observation at a comparatively late stage in the course of the disease, and are either dead or untraced.

In no case in which histological proof is lacking has it been claimed that the patient is symptom-free.

To indicate the extent of the disease, the well-known "League of Nations" classification has been adopted.

The series does not represent the results of a uniform method of treatment, but one which has been several times modified since the beginning.

The method employed has, in the great majority of the cases, been a cavitary one. At first radon, in tubes of varying content with a primary filtration of two and of three millimetres of lead, was used. At a later period a few of the patients were treated by a technique which involved needling the cervix. On few occasions a panhysterectomy was practised after apparent healing had been secured by radiation. The necessity for the adoption of some uniform method of treating patients was soon apparent, and this was realized through the help of the British Empire Cancer Campaign Society, which defrayed the cost of a set of tubes of radium salt. What is generally known as the Paris technique was then adopted. Up to the end of the series, twenty-two patients have

been treated by this method. More recently still the practice of supplementing the radium by a course of deep X radiation has been instituted. This is given immediately before or after the application of radium.

THE PRESENT METHOD OF TREATMENT.

The Paris technique, as described by Lacassagne, is followed very closely, though the equipment available does not permit the French method of X radiation to be duplicated exactly.

The entire length of the uterine canal is irradiated by a chaplet of tubes contained within the lumen of a rubber sheath. Usually three, sometimes four, tubes are used. They contain the equivalent of either 6·6 or 13·3 milligrammes of radium element, and the primary filtration is one millimetre of platinum. Similar tubes are employed in the vaginal vault, but in this situation the primary filtration is increased by 0·5 millimetre of platinum, and the secondary filtration consists of a cork cylinder with a wall thickness of 0·5 centimetre. The period of irradiation is a continuous one, extending over five days. The doses delivered in the uterine canal and the vaginal vault are usually each about 30 millicuries destroyed. The total dose is thus about 8,000 milligramme hours. Applicators are removed, sterilized and replaced daily, and this opportunity is also made use of to administer a vaginal douche and to attend to nursing details.

The method is a well-designed and flexible one, and it has been found worth while to adhere closely to it, even in regard to what may appear to be minor details.

In very few of the cases has any form of anæsthesia, other than a small dose of morphine and of hyoscine, been required. If it has seemed necessary, the usual resort has been to the induction of a "low" spinal anæsthesia by the intrathecal injection of 0·5 cubic centimetre of 10% "Stovaine" in saline solution. The injection is given with the patient in the sitting position, and this position is maintained for a few minutes. Even without anæsthesia, if dilatation of the cervix is done gently and slowly, it can usually be effected without causing the patient any severe discomfort. The process may with advantage be spread over two sessions on successive days. By doing so, the discomfort to the patient is lessened, and the occurrence of a rise in the temperature after the first treatment may indicate the presence of a latent septic infection. In that case the commencement of the radium treatment should be deferred until the temperature returns to normal, when the process may be cautiously recommenced.

If the cervical canal is not easily discovered, the search for it is abandoned, and only the vaginal portion of the treatment is carried out. A week later the canal is again sought for and is usually easily found and dilated. The treatment is then completed.

There are certain advantages to be gained by avoiding the use of general anæsthesia. A patient who has had the radium inserted under general narcosis, is likely to be apprehensive when subjected to daily dressings without this aid. It is also true that its use tends to turn

the procedure into a minor surgical operation, and this is not thought to be wholly desirable. The manipulations incidental to the radium treatment in a case of cervical cancer have little in common with the performance of a surgical operation, save the common necessity for the observance of the principles of asepsis. Most surgical procedures depend for their success upon the execution of a single procedure which may require the display of a considerable degree of judgement and skill. The post-operative management of such a case, as a rule, is a relatively simple affair, the carrying out of the details of which may well be entrusted to persons other than the operator himself. With radium therapy it is otherwise. Subsequent dressings and replacements are as important as the primary insertion, and should be carried out by the same person. Changes in the number and disposition of the applicators may be required as the treatment proceeds, and other modifications may be necessary.

THE COMPLICATIONS OF TREATMENT.

Sepsis, in one form or another, constitutes a most serious obstacle to effective radium therapy. Even with the most careful management, slight fever during the treatment is the rule rather than the exception. It is usual for this fever to subside when the radium is finally withdrawn. Infection, more or less severe, occurred in seven cases of the present series. Two of them required drainage either by suprapubic incision or by posterior colpotomy, and a third case ended fatally. In the other four cases the infection, though not so severe, was troublesome enough to require the abandonment of the method. A reliable means of anticipating its probable incidence would be invaluable.

A certain amount of help may be derived from a study of the previous history of the patient, the behaviour of the temperature when the patient is kept at rest in bed, and the presence or absence of leucocytosis.

In three of the seven cases some warning that infection might occur was obtained from one or other of these sources. The adoption, in the later cases of the series, of the standard Paris technique resulted in a notable decrease in the frequency and severity of these septic accidents. It is thought that two factors may have had some influence in producing this agreeable result. In the earlier cases the necessity for daily removal and replacement of the tubes was not fully appreciated. This practice is a very important detail in the technique of treatment. It greatly diminishes the foulness of the dressings and the incidence of infection, and it affords a valuable opportunity for the restoration in proper position of radio-active material which may have become displaced. The radon containers for intrauterine use which were previously employed had walls of lead two millimetres thick and a secondary filtration of two millimetres of rubber. The insertion of this apparatus required a considerable degree of dilatation of the cervix. The radium tubes in use at present with platinum walls and a thinner layer of rubber require the minimal amount of dilatation, and less trauma is inflicted in doing

so.   It is thought that the disturbance to the infiltrated and infected tissues occasioned by the relatively forcible measures employed to secure the greater degree of dilatation required in the earlier cases may have tended to provoke the septic process.

Proctitis.—In the period immediately following treatment the patient may complain of a group of symptoms which result from the effects of the radiation on the rectum.   The occurrence of this so-called proctitis is of considerable importance, for it indicates, in the given conditions under which the radiation is being practised, that the limits of toleration of the healthy tissues around the lesion are being approached.

In the present series the phenomenon was not observed in the cases in which doses of less than 25 millicuries destroyed were administered in the vaginal vault.   Doses of 30 millicuries destroyed usually produced it to a mild degree.   If the vaginal dose was raised to 42 millicuries destroyed, the reaction produced was intense and prolonged.   In several such cases a proctoscopic examination was made, but no changes in the appearance of the rectal mucosa were visible.

Fistula.—In several of the stage IV cases a vesico-vaginal or recto-vaginal fistula occurred as a natural result of the progress of the disease, but in only one case could the development of a fistula be fairly attributed to the effect of the radium.   This was the result of treating an extensively infiltrated vaginal wall by the insertion of radon "seeds".

Pain.—In no case of the series did radium treatment appear to cause or to aggravate pain.

In one case in which a fair amount of pain had been present before treatment, the pain persisted subsequently and gradually became worse.   In an attempt to secure relief, a pre-sacral neurectomy was performed.   For two months complete freedom from pain was obtained, but at the end of this period it recurred, and was soon as bad as ever it had been.

From the temporary nature of the result obtained by the operation in this, and in other reported cases, it does not appear to be worth trying, unless other means of relief are ineffective.

THE RELATIVE ADVANTAGES OF RADIUM AND RADON.

Radium salt was substituted for radon in the later cases of the series for reasons of convenience and not because of any superiority of radium itself as a source of radio-activity.   Variations in the amount of radon available at the time that it was required, were found to result in a certain amount of irregularity in the technique which made the comparison of results difficult.

The essential difference between the radiations furnished by radium and by radon is that the former are of constant and the latter of steadily diminishing intensity.   In the circumstances in which a source of radiation is employed for the relatively short period of a few days, there is no reason to suppose that this diminution in intensity results in any important modification of the biological effect produced.   The main disadvantage of radon for the present purpose is that it represents an

extravagant way of utilizing radio-active material, and this waste is greatest if a split-dose method, such as the Stockholm technique, is employed. Residues of radon remaining after a treatment can seldom be made use of without modifications which involve the dismantling of the applicators and the manipulations of their content of unscreened glass capillaries. This practice involves the person who carries it out in a certain amount of exposure to the action of unscreened radiations, and it is, for that reason, an undesirable and a dangerous one. If, however, some form of continuous treatment is used extending over a period of five days or more, the waste is much less.

The Present Results of Treatment.

International Classification according to extent of disease	Alive and Well.				Failure to Heal, or Recurrence.				Dead.				Untraced.			
	1929 1930	1930 1931	1931 1932	1932 1933	1929 1930	1930 1931	1931 1932	1932 1933	1929 1930	1930 1931	1931 1932	1932 1933	1929 1930	1930 1931	1931 1932	1932 1933
Stage 1 ..	—	5	1	5	1	—	—	—	—	3	—	1	—	—	—	—
Stage II	2	—	1	4	1	—	—	4	2	2	1	1	1	2	—	1
Stage III	1	—	—	1	—	—	—	—	9	2	2	2	1	—	—	—
Stage IV	—	—	—	—	—	—	—	3	3	3	—	2	—	—	—	—
Post-operative recurrence or development of cancer in cervical stump ..	3	5	2	1 / 11	2	—	—	7	14	1 / 11	3	6	1 / 3	2	—	1
				21				9				34				6

THE RESULTS OF TREATMENT.

The state of the treated cases at the end of 1933 is set out in the accompanying table.

The Factors Inimical to Successful Treatment.

Cure of the disease in its more advanced stages is exceptional by either radium or by surgery, and any hopes which may be entertained of improving the results of treatment must be based principally upon measures which secure a higher percentage of successes among these cases which fall within the first three groups of the international classification.

The alternative methods of radium and of radical surgery are available for stage I and stage II cases, and the failures occurring within

these groups have been thought to merit particular consideration. At the time of writing, the combined cases of stage I and stage II include twenty in which healing failed to take place or in which the disease eventually recurred. The records of these have been examined for the presence or absence of those factors which are generally known to prejudice the chances of a successful result.

Eight patients received doses of less than 40 millicuries destroyed and might be considered, according to present notions, to have received insufficient irradiation.

In seven cases there existed variations in technique, such as the employment of a method which involved needling the cervix. This group also includes two cases in which after a preliminary treatment with radium a panhysterectomy was undertaken within the next six weeks.

In three cases fairly severe sepsis was a complicating factor. One patient died of pulmonary tuberculosis shortly after the completion of treatment. One case (adeno-carcinoma) was complicated by pregnancy.

It is, of course, quite unjustifiable to assume that these defects or complications of treatment were solely responsible for the failure in any of the cases mentioned.

Included among the twenty failures are four cases in which no obvious adverse factors were present. In three of these the local lesion either failed to heal or else the period of freedom was brief and the disease soon showed evidence of spread within the pelvis. In the remaining case remote metastases occurred after a period of three years' apparent freedom.

Radio-Sensitivity.

The response of the primary lesion to γ radiation is highly satisfactory in nearly all cases of the disease in which the patients come for treatment at a reasonably early stage. This radio-sensitivity appears also to be shared by the local extensions of the disease to the vaginal mucosa and to the parametric regions. Whether or not cancerous deposits in the pelvic lymph nodes may also be destroyed by radiation is, however, an important question to which there is as yet no certain answer. Reasoning on the analogy of the well-known radio-resistance of secondary deposits in the lymph nodes of the neck, it has been assumed that the pelvic lymph nodes would behave in a similar way. It is, however, by no means certain that this is the case, and it is legitimate to hope that in future some of the cases in which extension to lymph nodes has occurred, may be successfully dealt with by improvements in the method.

It is difficult to escape the conclusion that some failures are attributable to a deficient irradiation of the periphery of the primary lesion itself. Studies by Mallet and Colliez upon the isodose curves of the intensity of radiation emitted by tubes placed in the uterine canal and fornices demonstrate clearly how limited is the surrounding zone of effective radiation.

In few situations other than the *cervix uteri* can a malignant tumour be successfully treated by a single focus of radio-activity placed at its centre, and what may be termed centripetal methods of irradiation nearly always yield better results.

The Prospect of Securing an Improvement in the Results.

Assuming that better results might be secured by providing for a more intense and more homogeneous irradiation of the primary tumour, it is possible to progress in this direction by the two devices of utilizing a higher filtration and consequently harder rays, and by extending the time during which the radiation is practised. The ideal of a homogeneous irradiation of sufficient intensity acting over a much wider field can, however, only be secured by such methods of external radiation as intensive high voltage X rays and by teleradium. Until the value of these methods is determined, either alone or in conjunction with the cavitary method, it cannot be said that radiotherapeutics as applied to uterine cancer has been fully exploited. It is evident that its ultimate worth will depend to a considerable extent on its power to arrest the disease in the group of cases in which metastatic deposits have occurred in the adjacent lymph nodes.

SUMMARY AND CONCLUSIONS.

1. The immediate results of the treatment, principally by radium, of a series of cases of cancer of the *cervix uteri* during a four-year period are set out.

2. The causes of failure are found to be due in the main to the extent to which the disease has spread locally before treatment is instituted and to a lesser but still important extent to the presence of certain well-known factors which influence adversely the results of radium therapy in this situation.

3. The opinion is expressed that treatment by methods of external irradiation, whether by radium or X rays, will assume a greatly increased importance in the future.

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SUPRAPUBIC PROSTATECTOMY WITH CLOSURE.[1]

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In this, the opening paper, it would serve no useful purpose to traverse the whole field of prostatectomy. It is proposed to bring forward for your detailed consideration, with an occasional digression, those methods which have for several years been the routine practice at the Urological Department of the Lewisham Hospital, in the earnest hope that you may be convinced not only of their intrinsic value, but that they are capable and deserving of general adoption. The every-day methods, it must be admitted, lack completeness and finish, and have for too long been a reproach to the surgery of the prostate.

It has for many years seemed to the author that the ideal operation of prostatectomy should, *inter alia*, provide for the control of hæmorrhage by suture, the total or even partial elimination of sepsis by covering over the raw surfaces, and, finally, the prevention of post-operative recurrence of obstruction by the reformation of the prostatic urethra. So far as the complete closure was concerned, it was felt that this, though of major importance on account of the prospect of increased comfort and shortened convalescence, should not be regarded as the primary aim, but rather that it should postulate an otherwise completely successful operation in a field rendered favourable for its accomplishment, and should in no circumstances be carried out unless the local conditions warranted it. To close a bladder that had not been made clean (which should be a rarity in a well-ordered clinic) or in which the hæmostasis was inadequate, could only be regarded as a grave surgical indiscretion.

The operation described herewith was evolved only after several years of experiment and endeavour, and in its present form has been practised by the author for upwards of six years.

This operation is characterized by a very easy convalescence, and patients submitted to it should, and do, require on the average far less individual, albeit skilled, attention after operation than those submitted to everyday methods of prostatectomy. It is evident from a perusal of the literature that this does not apply to some variations of the operation as practised in other clinics. Post-operative results, here as elsewhere, should act as a valuable corrective of surgical and nursing skill.

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[1] Read at the annual meeting of the Royal Australasian College of Surgeons, Adelaide, 1934.

Although it is by no means desired, and it would indeed be foolish, to claim that a panacea has been found for all the ills of prostatectomy, the operation represents, the author would fain believe, a very decided advance towards a realization of the ideal.

If this operation is to be successful, attention to detail is essential. There are two subsidiary factors of paramount importance, disregard of either of which is likely to spell failure to the plastic portion of the operation, however carefully this may be carried out. They are: (a) Surgical asepsis and antisepsis in the care of the indwelling catheter. This ritual must be rigidly observed both in the pre-operative and post-operative periods. Any carelessness in this regard will not only render the operation impracticable, but will, of a surety, reap its own harvest of post-operative septic sequelæ. (b) The intra-urethral method of digital enucleation of the prostate. With the method of bimanual intra-urethral enucleation employed (vide infra), which is an elaboration of that described many years ago by Bentley Squier, of New York, the verumontanum is preserved, the anterior commissure is not disturbed, and the mucosal covering of the greater part of the prostatic urethra is left intact (vide Figures IV and V).

So far as Freyer's method of enucleation is concerned, it is far too liable to entail complete removal in one piece not only of the prostate, but also of the verumontanum, of the entire prostatic and, in some cases, even of the membranous urethra (vide Figure V). An unnecessarily wide and particularly vulnerable area is thus opened up to infection, which, in its various grades, is so common a characteristic of this method of enucleation.

Further, no plastic reconstruction of the urethra can make up for the loss of the entire prostatic urethra which characterizes Freyer's method, and the long narrow stricture which is liable to form is one of the most recalcitrant of all post-operative sequelæ.

The open instrumental method of carrying out Freyer's technique is an even greater menace than the original digital method.

Freyer's methods of operation have served their purpose, and should now be finally discarded.

SOME OPERATIVE REQUIREMENTS.

The author's operation demands complete visual exposure of the base of the bladder. It may, if so desired, be performed through a long vertical or transverse abdominal incision when only one special instrument, namely, the combined needle and needle-holder, will be essential. The author, however, prefers to do it through a short transverse incision from 6·25 to 7·5 centimetres (two and a half to three inches) in length, for which a set of self-retaining, electrically lighted bladder retractors has been devised. Any suitable bladder retractors may be employed in conjunction with a larger incision. The author's set, however, permits the employment of a much smaller abdominal and bladder incision,

and thus, while not impairing the facility with which the successive steps of the operation may be carried out, enables post-operative drainage both of the bladder and of the prevesical space to be safely dispensed with. When, on the other hand, the operation is practised in conjunction with a long incision of the abdominal parietes and bladder, drainage either of the prevesical space or of the bladder must be provided. A voluminous personal correspondence, in addition to the author's own experience, stresses the importance of this statement. The use of the author's retractors renders the operation equally applicable to the two-stage operation, a statement which does not apply, so far as he is aware, to any other type of retractors.

FIGURE I. The author's large size boomerang needle. There is no cutting edge, the point alone is sharp. (Actual size.) By courtesy of *The British Journal of Surgery.*

Special Instruments.

The special instruments employed are four in number. They are as follows:

1. *The Boomerang Needle-Holder.* The boomerang needle-holder is now well known. An improved and perfected design is used. It is a modification, which the author has had made, of the well-known pattern of Young. The sole drawback in the past to the use of this needle-holder has, in the author's experience, been the occasional "jumping out" of the needle from the end of the needle-holder. This difficulty has now been overcome by replacing the locking pin of the original design with a small and readily adaptable double clip and pin device (*vide* Figure IX), which is positive in action and made of rustless steel. The actual length of the needle-holder assembled, excluding the needle, is 23.1 centimetres (nine and a quarter inches), while the over-all length, with the large size needle mounted, is 25 centimetres (ten inches). Two specially large size needles have been constructed for this holder (*vide* Figure I), the smaller being approximately two-thirds the size of the larger. The larger size needle is indispensable for the placing of the trigonal and of the anterior sutures in the operation now performed; the smaller needle does not take a sufficiently wide bite, and is employed only for the hæmostatic sutures.

In order to avoid hæmorrhage from the needle puncture it is essential that the needle should not have a terminal, sharp, cutting edge, but should be sharpened only at the actual point. It is made of rustless steel and must be kept sharp.

2. *The Ligature Carrier for the Boomerang Needle-Holder.* The ligature carrier for the boomerang needle-holder is also well known and requires no further description (*vide* Figure IX, insert 1).

3. *The Self-Retaining Frame and Bladder Retractors (vide* Figure II). The retractors comprise a set of two lateral and one posterior retractors, each electrically lighted. They have been exhibited and described so often that any further details are unnecessary here.
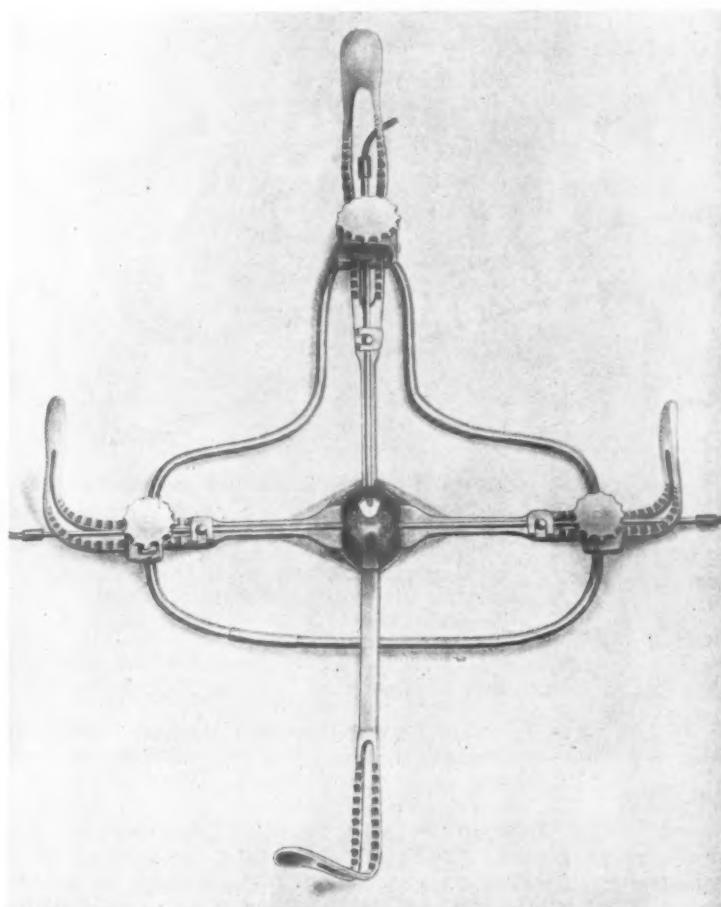

FIGURE II. The author's electrically lighted bladder retractors and self-retaining frame. The anterior retractor is not electrically lighted and does not connect with the frame. The complete exposure of the field of operation is well shown. The tip of the anterior retractor is seen lifting the anterior lip of the prostatic cavity forward. By courtesy of *The British Journal of Surgery.*

4. *The Anterior Retractor.* The anterior retractor is now made with an extensible blade. This, as heretofore, is set at an angle of 70° to the body of the retractor. The length of the blade closed is 8·75 centimetres (three and a half inches), extended 12·5 centimetres (five inches), and the width is 9·0 millimetres (three-eighths of an inch). It is recurved at the tip and made of spring steel (*vide* Figure III). It is not attached to the self-retaining frame, nor is it electrically lighted. In actual use its tip dips below the anterior lip of the prostatic rim and lifts this forward, thus widely opening up the prostatic cavity and greatly facilitating the accurate insertion of the sutures
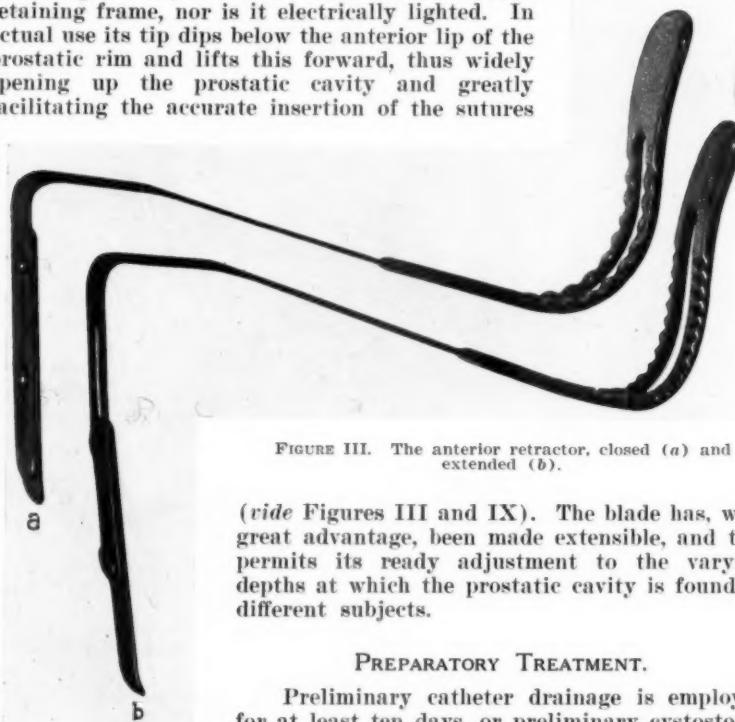
FIGURE III.   The anterior retractor, closed (*a*) and extended (*b*).

(*vide* Figures III and IX). The blade has, with great advantage, been made extensible, and this permits its ready adjustment to the varying depths at which the prostatic cavity is found in different subjects.

PREPARATORY TREATMENT.

Preliminary catheter drainage is employed for at least ten days, or preliminary cystostomy for at least one month, if catheterization is unsuccessful, if the urine is dirty, if the residual urine exceeds 120 cubic centimetres (four ounces), or if the renal function is below par. Patients whose general condition is below par, and who, for that reason, require pre-operative preparation, often improve to an extraordinary extent with a retained catheter, even when no residual urine is present and there is a normal renal function. The improved rest at night rendered possible is doubtless a potent factor.

Vas ligation for the prophylaxis of epididymitis is practised as a routine measure. The earlier in the preparatory treatment the insertion

of the sutures, the more successful will be the result.   Silkworm gut subcutaneous transfixion sutures are used and removed after seven days.

Method of Emptying an Over-Distended Bladder.   Any suitable rubber or silk catheter is passed and its funnel end is closed.   The smallest size hypodermic needle is then plunged through the wall of the catheter into its lumen.   A length of narrow rubber tubing connects the hypodermic needle to a bottle at the bedside.   Usually not more than 120 cubic centimetres (four ounces) of urine per hour are allowed to flow through the needle (though when polyuria is present more than this amount must be permitted).   To insure this it may be necessary partially to obstruct the rubber tubing.   When the bladder is emptied, generally at the end of twenty-four or thirty-six hours, the needle is removed and the catheter is connected up to a bottle at the bedside.

The following routine is rigidly insisted upon when a retained catheter is employed: The bladder is washed out thoroughly once or, in dirty cases, twice or even thrice daily with a solution of permanganate of potash of pale pink colour, then with plain sterile water, and completely emptied.   One hundred and twenty cubic centimetres (four fluid ounces) of a one in 3,000 solution of silver nitrate are then run into the bladder and the catheter is clamped for half an hour.   When the bladder is dirty, the strength of silver nitrate is increased gradually to the limit of tolerance, sometimes even up to one in 1,250.   Generally, the dirtier the bladder, the greater the tolerance for silver nitrate.   The silver nitrate solution must not be strong enough to cause pain.

The catheter is drained by a glass connecting tube and a length of rubber tubing into a bottle at the bedside containing antiseptic solution into which the tubing dips.   No method of antisepsis will clean up a dirty bladder, or prevent infection of a clean one, when the end of the catheter is placed, as is so often seen, in a urinal between the patient's thighs.

The catheter is changed at least every third day.   The patient, if well enough, is given a hot bath between changes of catheter.   Always before insertion of the catheter the *glans penis* is mopped with methylated spirit and the urethra is irrigated with a one in 5,000 solution of oxycyanide of mercury.   The catheter lubricant consists of one in 500 oxycyanide of mercury cream (tragacanth-glycerine).

Ammonium benzoate, 0·9 to 1·2 grammes (15 to 20 grains), is given by mouth three times a day, and hexamine, 0·6 gramme (10 grains), is given, also by mouth, three times a day or oftener.   When ammonium benzoate disagrees with the patient, acid ammonium phosphate is substituted in the same dosage.   This medication is continued throughout convalescence, except for a short remission after operation.

If this technique is faithfully carried out, there will be found few, even badly infected, bladders which cannot be very efficiently made clean; and the prostatic bed may thus be rendered a safe place for plastic surgery.

Confinement to bed is usual only for the first day or two of the catheter treatment. A comfortable chair and sunlight are great assets.

Indigo-Carmine Test. After a minimum of ten days when catheter drainage is employed, but not until such time as the patient's condition is considered otherwise favourable by the consulting physician, an intravenous injection of ten cubic centimetres of a 0·4% solution of indigo-carmine is given. One of Burroughs, Wellcome's tabloids in twenty cubic centimetres of water will suffice for two injections. Unless a good blue coloration appears in the urine within ten minutes, the patient is considered unsuitable for immediate prostatectomy, and is either further prepared by the retained catheter or submitted to preliminary cystostomy. In no circumstances is a prostatectomy undertaken, whatever the other tests of renal function may indicate, unless the result of the indigo-carmine test is considered good enough to warrant it. This is regarded as the final renal test of operability. Patients whose renal function would previously have been considered to render prostatectomy either hazardous or even inadmissible, are, under the present *régime*, offered the operation with confidence. Where formerly a dark blue coloration of the urine was deemed necessary in the final test of operability, operation is now safely undertaken in patients whose indigo-carmine test yields a very much lighter blue. Suitable efforts will, of course, have been made to bring it up to the usual dark blue coloration.

OPERATIVE TECHNIQUE.

The steps of the operation may be summarized as follows:

1. Irrigation of the urethra and washing out and complete emptying of the bladder immediately before the patient is brought to the theatre.

2. Draping of the towels on the patient in such a way that separate and individual access may be had to the rectum, penis and abdominal incision. This method has been described in detail in previous papers.

3. Transverse abdominal incision through the skin and fat, 6·75 to 7·5 centimetres (two and a half to three inches) in length and 2·5 centimetres (one inch) above the level of the *symphysis pubis*.

4. Incision of the bladder at the highest point, after pushing back the peritoneal reflection. All bleeding points on the cut edges of the bladder are carefully tied to insure that there will be no post-operative bleeding from this source.

5. The enucleation of the prostate. The bimanual method of intra-urethral enucleation of the prostate is employed, two fingers of the left hand, on which two gloves are worn, being passed into the rectum. With the small transverse abdominal incision the added assistance afforded by the fingers in the rectum is invaluable. The forefinger of the right hand is passed into the prostatic urethra and breaks its way through the mucous membrane at the antero-inferior aspect of one or other lateral lobe and immediately lateral to the verumontanum. The mesio-inferior aspect of each lateral lobe in turn is followed backwards

to the mid-line (*vide* Figure IV). Then, and then only, is the enucleating finger swept round the outer aspect of each lateral lobe, from before backwards to the mid-line. The verumontanum is preserved, the anterior commissure is rarely disturbed and much of the prostatic urethra remains intact (*vide* Figure V). By this method the prostate can be cleanly and speedily removed with the greatest gentleness and facility.
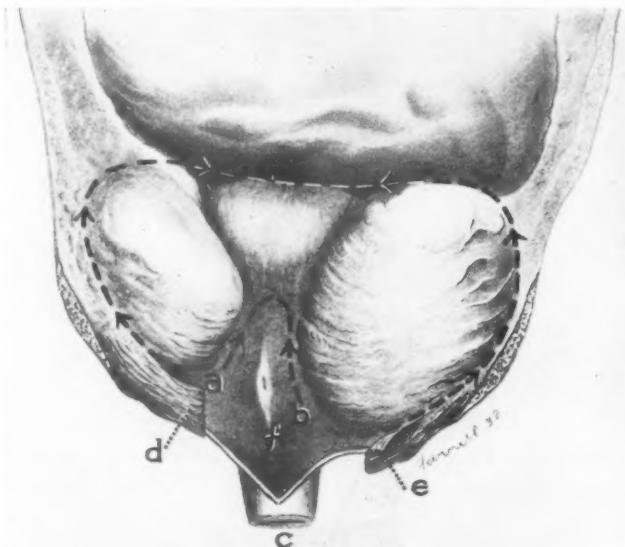

FIGURE IV. Drawing of *post mortem* specimen of bladder and prostatic urethra, opened from the front, illustrating the intra-urethral method of enucleation of the prostate described in the text. The broken black line and the arrows thereon indicate the course followed by the finger during the enucleation. The points *a* and *b*, opposite the antero-inferior aspect of each lateral lobe, indicate the site at which the enucleation is begun on each side; *d* and *e* indicate the cut edges of the muscle of the anterior commissure; *c* indicates the membranous urethra. By courtesy of *The British Journal of Surgery.*

This result is accomplished with an almost complete absence of bruising and with a minimal disturbance of the surrounding tissues.

6. Placing in position of the bladder retractors.

7. Visualization of the prostatic cavity and removal of any adenomatous remnants or tags.

8. Insertion of the individual hæmostatic sutures in the postero-lateral segment of the prostatic rim to control the gross hæmorrhage (*vide infra*).

9. Retrigonization, or reconstruction of the floor, of the prostatic urethra by suturing the trigone of the bladder into the prostatic cavity.

This step was forecast by the author at the second session of the Australasian Medical Congress (British Medical Association) on March 26, 1927. The details were published in *The Medical Journal of Australia* in March, 1927. Owing to technical difficulties, it was not put into practice until eight months later.
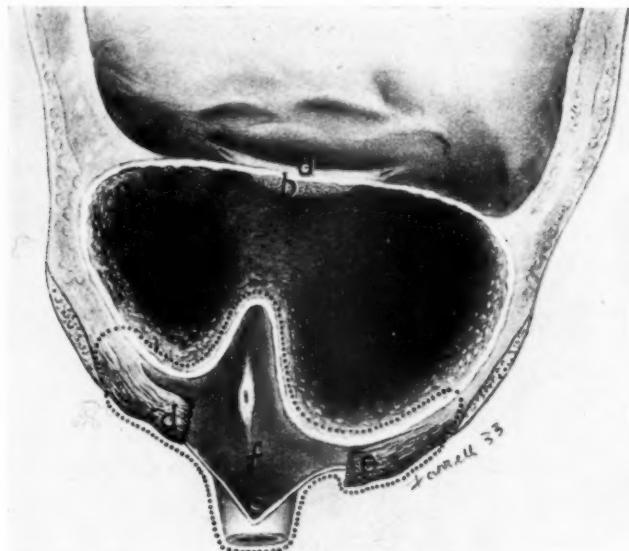

FIGURE V.   Same specimen as Figure IV after enucleation of the prostate. The heavy white line outlines the resulting cavity. It will be noted that the membranous urethra, the verumontanum and the prostatic urethra around and distal to it have been left intact. The anterior commissure has been divided in this specimen for the purpose of exposing the interior of the prostatic urethra; during an actual operation it is left intact. The dotted black line surrounds the additional area which is commonly removed when the Freyer, particularly the open instrumental, method of prostatectomy is employed. *a* = the inter-ureteric bar; *b* = the trigonal muscle; *c* = the membranous urethra; *d* and *e* = the cut edges of the muscle of the anterior commissure; *f* = the verumontanum (semi-diagrammatic). By courtesy of *The British Journal of Surgery*.

Normally the apical portion of the trigone dips downwards at an obtuse angle over the posterior lip of the vesical sphincter and terminates in the region of the verumontanum, which is its point of insertion. In prostatic hypertrophy associated with posterior commissural hypertrophy or middle lobe enlargement, the apical portion of the trigone is pushed up into the bladder, and after prostatectomy it is torn across and severed from its distal connexions and is completely retracted into the bladder.

The term "retrigonization", which has been coined by the author, is aptly descriptive of the method designed by him to secure the apex of
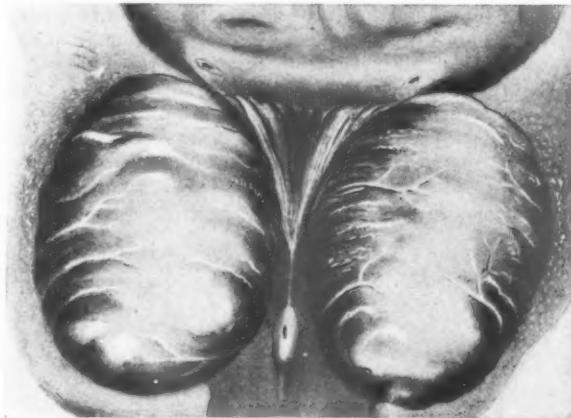
FIGURE VI. Drawing of *post mortem* specimen of bladder and prostatic urethra opened from the front, and showing lateral lobe enlargement of the prostate with a perfectly normal posterior commissure. By courtesy of *The British Journal of Surgery*.
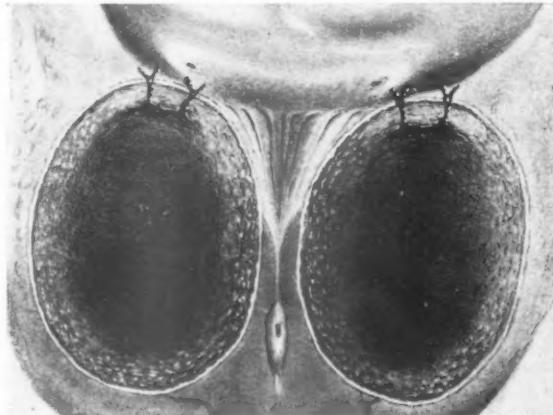
FIGURE VII. Same case as Figure VI after removal of the lateral lobes. The trigone has remained undisturbed in its normal position. Two hæmostatic sutures are shown on each side (semi-diagrammatic). By courtesy of *The British Journal of Surgery*.

the trigone in the prostatic urethra. It creates a replica of the normal anatomical and physiological relationship (*vide* Figures VII and VIII).

Retrigonization, during the six and a half years that it has been employed, has been so completely successful in preventing post-operative obstruction that it should be considered an integral part of the operation of prostatectomy. By no other means can post-operative recurrence of obstruction in this situation be, with certainty, avoided.

10. Obliteration of the prostatic cavity and reformation, at least in part, of the side walls of the new prostatic urethra by means of two deep anterior transverse sutures of number 3 plain catgut. This step also finally controls the venous oozing that always takes place from the prostatic cavity after prostatectomy. Very rarely a third suture may

FIGURE VIII.   From the same specimen as Figures IV and V. The trigone is shown sutured in position as in the author's operation. This figure is pre-inserted here for ready comparison with Figures VI and VII and to emphasize the close reproduction attained of the normal anatomical relationship of the trigone and the prostatic urethra (semi-diagrammatic).   By courtesy of
The British Journal of Surgery.

be required when an extra large cavity is present. All bleeding should be controlled before the passage of the urethral catheter. The catheter itself plays no part in the control of hæmorrhage, ample room always being left round it to allow of drainage upwards into the bladder from the remnant of the prostatic cavity. Experience has proved that tight suturing of the prostatic rim round the catheter predisposes to sloughing of the adjacent parts and to secondary hæmorrhage.

11. Insertion through the urethra into the bladder of a rubber catheter size 22 French, preparation of its vesical end and transfixion by a needle threaded with silkworm gut (*vide infra*).

12. Valvular closure of the bladder, obliteration of the space of Retzius, and closure of the lower angle of the incision in the aponeurosis by one single three-looped extended figure-of-eight suture of number 3

plain catgut (*ride* Figure XIII). This suture has been described in detail in previous publications. If, for any reason, an incision somewhat longer than usual has been made in the bladder, or if the original incision has been unduly stretched, the lower angle is first closed separately by one or two figure-of-eight sutures. These serve both to bring the muscle of the bladder wall together and to invert the cut edges in this situation. The remainder of the bladder incision is then closed by the single three-looped suture.

13. Complete closure of the abdominal wound. In the past one hundred cases only two were not completely closed, one patient being very fat with a deep pelvis in whom the hæmostasis was incomplete, the other had a penile stricture which would not allow the passage of the 22 French catheter. On only one occasion in the past one hundred cases has the bladder been reopened at any time after operation. This patient was the subject of secondary hæmorrhage on the ninth day. He ultimately made a complete recovery.

The greater the experience of the operator with the technical details of this operation, the larger will be the proportion of cases in which he can safely carry out the complete closure. *Per contra,* it cannot be too strongly emphasized that in no circumstances whatever should the complete closure be carried out where hæmorrhage has not been adequately controlled by suture, where the pre-operative cleaning of the bladder has not been efficient, or where a long incision has been made in the bladder or abdominal parietes.

14. Suspension of the vesical end of the catheter by tying the silkworm gut transfixion suture round a glass rod lying on the abdominal wall (*ride* Figure XIII). The catheter is removed on the tenth day. At no time thereafter is the passage of a urethral sound necessary when retrigonization of the prostatic urethra has been carried out.

The Postero-Lateral Hæmostatic Sutures.

From two to four sutures of number 2 plain catgut are placed deeply on either side of the mid-line in the posterior third of the rim of the prostatic cavity (*ride* Figures VII, VIII and IX), the smaller of the author's boomerang needles being used. From this situation alone, in a properly conducted enucleation, may the gross hæmorrhage be anticipated. Should bleeding persist, further sutures should be placed as required. If the bleeding should be coming from in between two sutures, the loose ends of these sutures may be tied together. In no circumstances, however, is a hæmostatic suture of one side tied across the mid-line to a hæmostatic suture on the other side, as this would prevent satisfactory retrigonization and thus deliberately encourage ledge formation.

After bleeding has been controlled in the region served by these postero-lateral sutures, careful inspection will occasionally reveal gross bleeding from a large artery or vein lying deeply on the more anterior

portion of the prostatic rim.   When this occurs an individual suture should be placed around the bleeding point, since the anterior obliteratives sutures, when they are tied, may not afford sufficient compression.
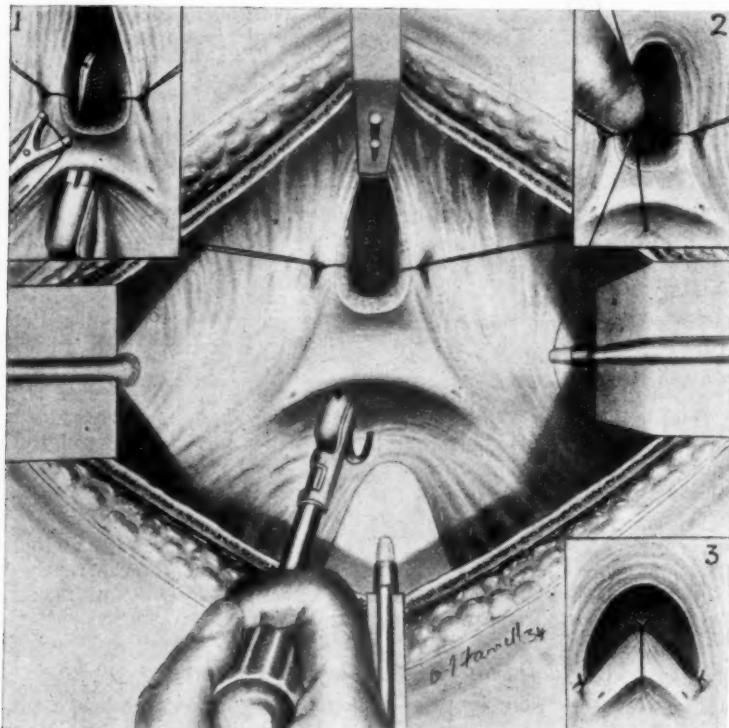

FIGURE IX.   Illustrating the retrigonization of the prostatic urethra.   The main figure shows the point of entry of the needle in the bladder base well down behind the inter-ureteric bar.   Insert 1 shows the point of emergence of the needle well forward in the prostatic cavity and the suture carrier approaching the needle. Insert 2 shows, the retrigonization suture being tied, with the forefinger of the left hand pressing the loop well down into the prostatic cavity.   Insert 3 shows the retrigonization suture tied, sewing the trigone well down into the prostatic cavity, both obliterating the ledge in this situation and reforming, at least in part, the new prostatic urethra.   Two hæmostatic sutures only are illustrated in all figures for the sake of simplicity.

It is a *sine qua non* that all bleeding from the prostatic rim must be definitely checked before proceeding further.

As has been pointed out by the author in previous papers, when the bleeding is arterial, the sutures should be placed in the prostatic rim in front of the bleeding point; when venous, behind.

The Posterior or Retrigonization Suture.

When the posterior or retrigonization suture is tied, the torn apex of the trigone is carried down into the prostatic cavity; retrigonization is brought about and the floor of the prostatic urethra is reconstructed.

Owing to a technical improvement in the placing of this suture, the difficulties of this stage of the operation have disappeared. The point of entry of the needle is now well down behind the inter-ureteric bar or base of the trigone, generally at the deepest part of the *bas fond* (*vide* Figures IX and X); it is, of course, necessary to visualize the ureteral orifices before inserting the needle. No fear need then be entertained of compression of them when the suture is tied. The point of emergence of the needle is deep down in the floor of the prostatic cavity (*vide* Figure X). A much wider and deeper extent of tissue is, with ease and certainty, included in the bite of the needle than was previously possible when the point of entry was at the base of the trigone. The special capsule forceps, hitherto employed at this stage of the operation, are now rarely, if ever, necessary.


FIGURE X. Illustrating the needle track, *a-b*, for the retrigonization suture. A sectional view of the prostatic environs after prostatectomy. *a* = point of entry of the needle; *b* = point of exit; *c* = verumontanum; *d* = torn apex of trigone; *e* = base of trigone.

The deeper the apex of the trigone is carried into the prostatic cavity the better, and it must at the least be deep enough to insure that the horizontal muscular ledge which appears in this position after removal of the prostate is converted into a smooth vertical gutter. The lowering of the bladder outlet will be even further accentuated when the anterior transverse sutures are tied (*vide* Figure XII), and the trigone becomes firmly bedded in position.

While the retrigonization suture is being tied, the tip of the operator's left forefinger, if he is standing on the patient's left side (which is the author's practice), should push down the knot as far as possible into the prostatic cavity; this insures that the trigone will be carried down to the lowest part of the loop when it is tied. If the right forefinger be used for this purpose, it will be found very difficult

to pass it deeply enough into the prostatic cavity, and the tendency will be to draw the trigone upwards away from the prostatic cavity when tying the knot.

The Anterior Transverse Obliterative Sutures.

A higher degree of efficiency has been attained for the anterior transverse obliterative sutures by considerably increasing the width of their embrace. There results from this not only more nearly complete obliteration of the prostatic cavity and better hæmostasis of the prostatic bed, but also a wide inversion of the rim and adjoining portion of the bladder base, the side walls of the new prostatic urethra being thus largely reformed. During the process of tying these sutures the trigone and bladder outlet sink progressively to a lower plane, u n t i l finally the trigone disappears almost entirely from view. At the termination of t h i s portion of the operation there should be no visible raw surface and no bleeding.


FIGURE XI. Needle in position for the first anterior transverse obliterative suture. Note the width of the bite of the needle. Retrigonization suture in position. Two only hæmostatic sutures are illustrated for the sake of simplicity. By courtesy of *The British Journal of Surgery*.

In the great majority of cases two anterior transverse obliterative sutures are employed, though one may suffice for a very small cavity, and a particularly l a r g e cavity may very occasionally demand the use of three. One suture is tied before the next is placed.

The first or most anterior suture passes transversely at a tangent to the anterior segment of the prostatic rim (*vide* Figure XI). The second is parallel to the first and bisects what remains of the prostatic cavity. These sutures traverse the prostatic cavity deeply from side to side, just missing its floor in the depths. They will lie above and in front of the catheter when it is passed.

Preparation of the Retained Catheter.

A thin-walled wide-bore rubber catheter of size 22 French is employed. This is estimated by gauge and not by the maker's marking. A calibrator (size number 12 F. gauge) is always passed to determine that there is no undue narrowing at any point throughout the lumen of the catheter, as actual diaphragm formation owing to faulty manufacture is not uncommonly detected.

After the catheter is passed into the bladder a second eye is cut about 3·75 centimetres (one and a half inches) from the tip, and the end of the catheter is cut off transversely just beyond this new eye. The full calibre of the catheter is thus made available for drainage (*vide* Figure XII).
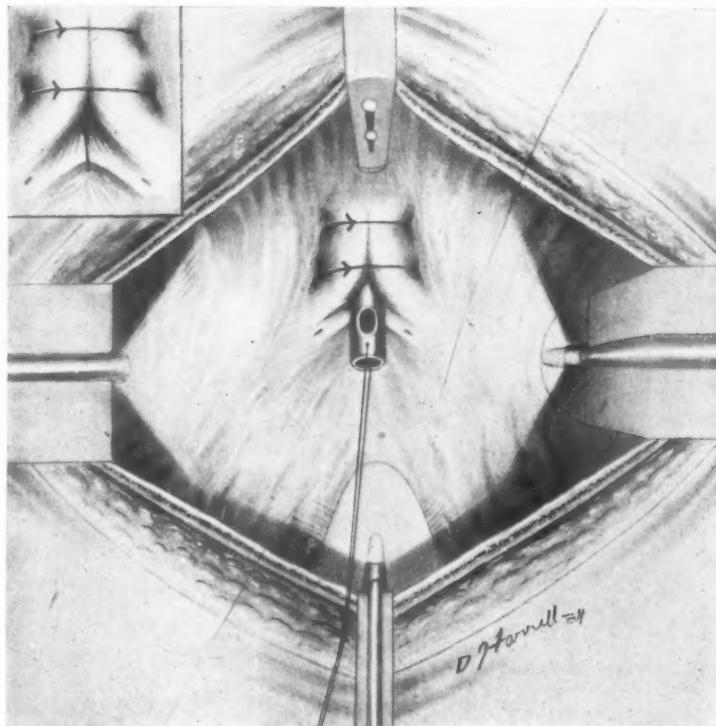

FIGURE XII. Anterior transverse obliterative sutures inserted; catheter with silk-worm gut transfixion suture in position. Plastic operation complete. (The catheter is passed intact and the tip cut off after a second eye has been made.)   Insert: Same stage before the passage of the catheter. Note that there is no visible raw surface, that the trigone lies on a plane below the rest of the bladder base and is firmly bedded in position, and that the lateral edges of the prostatic rim are deeply inverted, thus partly reforming the side walls of the new prostatic urethra.

If, as occasionally happens, it is found that the catheter is too large to pass through the urethra into the bladder, no apprehension need be felt, as the catheter plays no part either in the control of hæmorrhage or in the urethral reconstruction. In these circumstances the catheter is omitted and suprapubic drainage is instituted. The bladder will be found to close rapidly after removal of the suprapubic drainage tube.

E

TWO-STAGE PROSTATECTOMY WITH CLOSURE.

The same plastic technique is applicable to the two-stage operation. In the first stage a transverse incision is made 5·0 centimetres (two inches) instead of 2·5 centimetres (one inch) above the symphysis, and room is left by this means for a vertical incision downwards in the
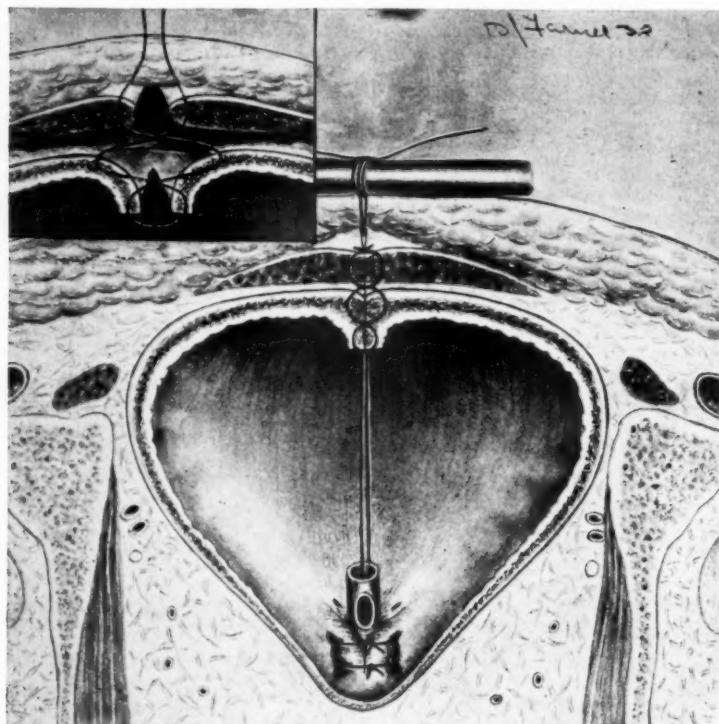
FIGURE XIII.   Sectional view of the completed operation seen from below. The three-loop suture is tied, approximating the bladder muscle, making a valvular inversion of the cut edges, obliterating the space of Retzius and closing the lower angle of the incision in the aponeurosis.   The catheter is tethered to the glass rod lying on the abdomen.   Insert : The three-loop or extended figure-of-eight suture, partially tightened.   The catheter suture has been omitted to avoid confusion.   By courtesy of *The British Journal of Surgery.*

second stage.   Water-tight closure of the bladder and abdominal wall is, of course, not so readily obtained in these cases.   It is surprising, however, how little urinary leakage actually occurs.

POST-OPERATIVE CATHETER DRAINAGE.

At the termination of the operation, and before the patient leaves the operating table, a few syringefuls of a solution of one in 3,000 nitrate

of silver combined with 4% citrate of soda are run backwards and forwards through the catheter to remove the blood clot which the catheter will have collected during its introduction. A wide-bore glass connexion is then placed in the funnel end of the catheter and inserted into a sterilized 240 cubic centimetre (eight ounce) glass bottle containing sufficient sterile solution to immerse the end of the glass connexion. When the patient is returned to bed the catheter is connected up in the usual way by a length of rubber tubing to a bottle at the bedside.

During the first twenty-four hours the majority of patients receive through the catheter from two to four injections of the nitrate of silver-citrate of soda solution mentioned above. Not more than 30 cubic centimetre (one fluid ounce) at a time are run in through the catheter. This is repeated as often as necessary to insure an unobstructed flow. After the first twenty-four hours the sodium citrate is omitted from the solution.

Irrigation beyond the amount necessary to insure the free flow through the catheter is not permitted. It should be called for only at odd intervals, if at all, during the remainder of the period of retention of the catheter.

Spasmodic and painful contractions of the bladder sometimes occur during the first two or three days of convalescence, especially in fat patients. This can generally be overcome or minimized by leading the rubber drainage tubing from the catheter below instead of over the patient's thighs.

The catheter is retained in position until the tenth day after operation. It is removed by cutting across the silkworm gut suture immediately below the glass rod. The hairpin-shaped remnant of silkworm gut comes away with the catheter. Most patients are out of bed on the eleventh day.

POST-OPERATIVE HÆMORRHAGE.

Post-operative hæmorrhage, reactionary or secondary, of sufficient severity to demand reopening of the bladder has been extremely rare throughout the entire series, and may, almost without exception, be regarded as evidence of incomplete or faulty technique. There was no case of primary hæmorrhage, and only one of secondary hæmorrhage in the past one hundred operations.

It is axiomatic that no bladder should ever be completely closed when the bleeding has not been adequately controlled. On this point there should be no room for errors in judgement.

An injection into the buttock of from 30 to 60 cubic centimetres (one to two fluid ounces) of whole blood, which need not be typed for this purpose, has seemed of value in the few cases in which its use was called for on account of the persistent formation of clots interfering with the continuity of drainage through the catheter, either before or after prostatectomy.

SUMMARY.

1. The operation of suprapubic prostatectomy with closure introduced by the author six and a half years ago is described. It has been carried out in 469 cases with 13 deaths and a mortality rate of 2·7%.

2. The technique is equally applicable to one- and two-stage operations.

3. The routine pre-operative and post-operative treatment employed in the Urological Department of the Lewisham Hospital is outlined.

4. Particular reference is made to the method employed for the control of hæmorrhage by suture.

5. The method of retrigonization, or reconstruction of the floor, of the prostatic urethra is described in detail. The experience of six and a half years without a single instance of recurrence of obstruction warrants the claim that this step should now be regarded as an integral part of the operation of prostatectomy.

6. The complete closure, while a valuable feature of the operation, must not be regarded as the primary aim. It should be practised only when the local conditions warrant it. It should be regarded as the fulfilment of a successful operation in a field rendered favourable for its accomplishment. The complete closure has been carried out in all except two instances in the past 100 operations.

POST-OPERATIVE PULMONARY COMPLICATIONS.

By H. HUME TURNBULL,
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Up to comparatively recent times post-operative pulmonary complications were usually regarded as due to the baneful effects of the anæsthetic on the bronchi and lungs, and remedies were sought in improvements in anæsthesia or in the use of anæsthetics which were not inhaled.

An apparent increase in these complications since the beginning of this century stimulated inquiry, and it was found that in most general hospitals this increase had actually taken place.

A review of the figures, however, shows that the increased percentage applies wholly to abdominal operations, those performed on the limbs being followed by a very small percentage of pulmonary lesions. C. C. Stewart[1] reports from the Montreal General Hospital the figures shown in Table I for post-operative pulmonary complications in cases in which operation was performed under ether anæsthesia in the years 1929-30.

TABLE I.

Site of Operation.			Number of Operations.	Post-operative Pulmonary Complications.	Percentage of Post-operative Pulmonary Complications.	Deaths.
Upper abdominal	..	..	509	29	5·7	10
Lower abdominal	..	..	1,174	25	2·1	1
Non-abdominal ..	..	..	3,331	12	0·36	3

Howden[2] gives the frequency of broncho-pneumonia in 6,521 cases in which operation was performed under general anæsthesia at the Melbourne Hospital in the years 1930-31 (Table II).

TABLE II.

Site of Operation.			Number of Operations.	Broncho-pneumonia.	Percentage of Broncho-pneumonia.	Deaths.
Upper abdominal	..	..	380	16	4·1	11
Lower abdominal	..	..	1,298	37	2·8	20
Non-abdominal ..	..	..	4,843	23	0·5	16

We can dismiss at once such conditions as the exacerbation of a quiescent tuberculous lesion after operation under ether, as, though this is a real thing, it very seldom shows itself till after the patient has left hospital, and so does not greatly concern the operating surgeon.

What concern us today are the pulmonary complications which may arise and which may cause anxiety after operation in a patient in whom the lungs were not so affected before operation.

As will be seen, chronic bronchitis, emphysema or any infection of the air passages increases greatly the probability of complication.

There is no time, nor is there need, to review the various conjectures which have been made in the past, and I would therefore state at once that the lesions can be divided into two sections: (i) embolism, which may cause infarction; (ii) atelectasis, which may cause simple collapse of the lung, pneumonia with lobar or lobular distribution or abscess. Pleural involvement with simple effusion, or empyema caused by spread of inflammation from surrounding structures is deliberately omitted.

EMBOLISM.

The most dreaded of these complications is the massive embolism, where a large clot occludes one or other pulmonary artery, usually the right, or straddles the bifurcation occluding both.

The latter condition is, of course, incompatible with life, the patient dying instantly or in a very few moments from shock or right heart failure.

If only one main branch is blocked, life may be prolonged for a time, but death is inevitable unless the obstruction can be removed.

The first hint of this tragedy may be a sudden desire to defæcate, which Lindsay suggests may be due to a reflex set up by the shifting clot, as the impulse to defæcate is rapidly followed by the fatal collapse.

The clot which causes this condition is large and certainly comes from some great vessel, such as the femoral, internal iliac or *cava*, or very rarely from the heart itself, and not from the site of operation. Among 31 large London hospitals in 1924 in 54,253 operations there were 50 fatal cases of post-operative pulmonary embolism, of which 43 followed abdominal operations. Of 23 cases of pulmonary embolism found at necropsy at the Middlesex Hospital in the years 1923-26, all but three followed abdominal operations.

If the clot be smaller and passes through the main branches to lodge in a moderate sized vessel, we get the picture of pulmonary infarction, sudden onset with severe cutting pain, difficulty in breathing, cyanosis and shock, accompanied often by cough, and a rapid pulse rate.

Later the temperature rises and on examination dulness and weak breath sounds are found over the affected area, with a pleural rub and later often tubular breathing.

The acute respiratory distress passes off and later blood or deeply blood-stained mucus is coughed up. The temperature gradually rises to about $37.8°$ to $38.9°$ C. ($100°$ to $102°$ F.), and the pulse settles at

about 110 to 120, with raised respiratory rate; then both gradually fall, the temperature by lysis.   Such emboli are rarely infected, and if the patient survives the initial shock the prognosis is usually good.

If the infarcted area is on the inner surface of the lobe no signs of pleurisy may be found, and indeed the only evidence of the accident may be the blood-stained sputum and the rise in temperature.   Such infarcts are not very large, or they would extend to the outer surface of the lung and give signs.

It is well to remember that post-operative hæmoptysis means pulmonary infarction and not tuberculosis.

Emboli usually separate about the tenth day after operation, but the time varies and may be much later.   Age is certainly a factor, and the condition is much commoner after fifty than before it.   Of course, this condition is not limited to post-operative cases, but is quite common in medical cases, especially in the cachexia of malignant disease or in feeble persons.

There is no real evidence of infection in the affected veins, and sepsis seems to be at most a contributing cause lowering vitality.

Feeble circulation may aid clotting, also changes in the blood, such as profound anæmia, increased blood calcium from long continued milk diet, and dehydration from vomiting and purgation.

Cramped positions, such as Fowler's position, which give rise to a double kink in the large veins from the lower extremities, aid stasis and clotting, and interference with abdominal respiration by such a posture removes a very useful pumping effect.

It is worth considering whether the same advantages could not be got by some more reasonable posture.   A special bed with adjustable sections like Lewis's cardiac bed,[3] which would allow of varying degrees of flexion at the hips and knees while the patient is kept in a sitting position, would be of value, but frequent change of position from side to side is most desirable.

Treatment.

The treatment of pulmonary infarction can be summed up in two words: reassurance and morphine.   The patient is naturally much alarmed and the calm assumption of a satisfactory outcome by his attendants is of great value.   This assumption is justified as, except in the case of large clots which block the main vessels, recovery is the rule.   Shock may be considerable at first and an injection of morphine, 0·015 gramme (one-quarter of a grain), is of the utmost value.   The patient should be allowed to assume the position of greatest comfort, but this is usually sitting or propped up on pillows, and he must be kept warm without being burdened with too much clothing.   A light cotton wool covering of the pneumonia jacket type or a cotton wool pad on the front of the chest assures this satisfactorily without discomfort.   Oxygen, though rarely necessary, may give relief for a time, but it is very seldom necessary to continue the administration for long,

and it has the disadvantage of frightening some patients. If pain is severe, a few leeches relieve it more completely than any other application, but in most cases a firm though not tight bandage round the lower ribs is sufficient to prevent excessive suffering. The morphine may have to be repeated, but rarely more than once, and simple analgesics are effective later. It is well to warn the patient that he will probably bring up some blood-stained sputum and that it is unimportant.

The ultimate prognosis is good. Such infarcts do not cause abscess formation, except in pyæmic cases, and the damaged lung returns to a normal state in time.

Though we read of permanent shortwindedness and cardiac damage, I have never seen anything of the kind, though I have had many patients with very extensive infarction who recovered completely.

ATELECTASIS.

Atelectasis is of more practical interest to the clinician at present, because its prevention and treatment seem more within our control. Its production by the mechanical occlusion of a bronchus was shown by Traube in 1844, and Lichtheim in 1879 demonstrated it clearly; but the subject was allowed to remain in abeyance for many years till Pasteur's work on what he called massive collapse of the lung in 1890 and succeeding years emphasized the frequent occurrence of such a collapse. Later work by many observers, especially Chevalier Jackson and his school with the bronchoscope, clarified the ætiology of the condition, and showed that atelectasis was caused by obstruction of the bronchus and not by paralysis of the diaphragm. There is no time to follow out the work in any detail, but I shall take it as proved and consider its bearing on post-operative lung conditions.

Coryllos and Birnbaum[4] state that:

Atelectasis occurs when bronchial obstruction is complete and pulmonary circulation normal; without these two factors atelectasis cannot occur. There are many contributory factors in atelectasis, such as absence of cough, splinting of the chest, œdema of the bronchial mucosa, and viscid sputum, but there is only one mechanism of its production—bronchial obstruction.

It is easy to see how the conditions existing after an abdominal operation favour atelectasis. Some increased bronchial secretion may be present.

(*a*) In elderly patients some degree of chronic bronchitis is common.

(*b*) A cold or mild influenza may be present and be overlooked by the surgeon, as no signs are found on examination and the patient does not mention it.

(*c*) Chilling of the patient at the time of operation, on the way back to the ward, or in the ward, may awake an existing mild infection.

(*d*) Pressure on the trachea or bronchi by a tumour, for example goitre, may cause increased secretion.

(*e*) Irritation by the anæsthetic in a susceptible patient, for example, a heavy cigarette smoker, may increase secretion.

(*f*) Material may be aspirated, blood or pus from throat, nose or mouth, excessive saliva, foreign bodies or food, which may irritate the mucous membrane.

Where for any reason there is an increased secretion, especially if it is viscid, it may collect in a bronchus, most commonly the main lower bronchus on the side towards which the patient lies, and if anything interferes with coughing and deep breathing this bronchus may be occluded and atelectasis follows. The patient then is seized by a sudden dyspnœa with often pain in the side, slight cyanosis, some degree of shock, and the temperature and pulse rise rapidly. Examination shows that side to be relatively flattened and immobile, percussion note to be dull, breath sounds weak or absent, sometimes bronchial in the upper portion; and the heart is displaced towards the collapsed side. X rays show some degree of opacity, a raised diaphragm and the heart and mediastinal structures displaced to the affected side. Sputum is rarely present and never blood stained. The later results depend on the nature of the infection in the secretion below the occluding mass. If this be of mild or negligible virulence, there will be no further change, and when, as a result of treatment or otherwise, the obstruction is removed and the lung can expand, recovery will be rapid. If, however, pneumococci of a considerable degree of virulence are present, unless the obstruction is cleared in twenty-four to thirty-six hours, the bronchial mucosa swells and the inflammation spreads in the involved area, with the production of a true post-operative pneumonia.

Staphylococci and streptococci seem more usually associated with the smaller lobular atelectases. If anaerobic organisms are imprisoned, as in the cases of infected blood or tissue aspirated in throat operations, tonsillectomy *et cetera*, destruction of tissue may follow the pneumonitis with the production of abscess.

Although I have discussed chiefly the production of a large lobar collapse, it is much commoner in practice to find that moderate sized bronchi are occluded, giving rise to smaller areas of collapse, and these are multiple as a rule. The degree of distress which is caused depends on the amount of lung which is affected and the virulence of the organisms in the bronchi. If only a small atelectasis occurs and the organisms are of low virulence, there may be no symptoms, even in the presence of signs of consolidation, or only cough and a slight rise of temperature, but if a large area is involved the symptoms are more severe and may be almost as great as those of lobar atelectasis. Even when only small areas are collapsed, if the organisms concerned are virulent and the bronchi are not rapidly cleared, pneumonic changes soon appear, and the picture of a true bronchopneumonia is produced. As Gairdner pointed out in 1850, this is almost certainly the mechanism of production of bronchopneumonia in such diseases as measles.

If this mode of production be admitted, we can see that the main problem confronting the surgeon is that of keeping the bronchial tubes

clear and preventing plugging, and that the anæsthetic *per se* is of comparatively slight importance.

It may be pointed out that the plug is not necessarily a solid mass of secretion, but if moderately thick secretion exists along a length of the bronchus, especially if there is some mucosal swelling, it may be enough to prevent the ingress of air and so cause atelectasis.

Prevention.

How, then, are we to prevent the onset of such a condition? It is interesting to note that wherever any line of treatment is carefully tried and the results are followed over a series of cases, the results are better than those in the general hospital service. This seems to be the case with widely differing points of view, and it is suggested that the real value is that the patient is carefully watched and relieved of discomforts at once before any severe blockage of tubes is attained. Also such complications are much commoner in public hospitals than in private practice. This, I think, can be readily explained by the fact that insufficient staffs in the former make it impossible to give the necessary care and attention to patients before and after operation.

The problems then are two:

1. The avoidance of bronchitis and excessive bronchial secretion. (*a*) By care in the detection of active or recent infections of the respiratory tract, and, if possible, postponement of operation in their presence. In cases of bronchiectasis or bronchorrhœa, pre-operative bronchoscopy with removal of secretion has been shown to be of great value. Faulkner and Faulkner[5] have used bronchoscopy on the table in cases in which rhonchi and severe respiratory difficulty developed. The thick viscid secretion was sucked out with entirely satisfactory results. (*b*) Protection of the patient from chills and draughts in the theatre and ward and on the passage between them, especially after operation.

2. Securing full deep inspiratory efforts during the post-operative period and the proper drainage of the lungs, especially of the lower lobes. The chief conditions which interfere with this and need study are: (*a*) Pain on breathing, which tends to limit its depth and which is most marked in the case of abdominal and especially upper abdominal operations. This may be combated by properly applied binders or bandages which support the upper part of the abdomen and lower ribs, so that cough is aided and respiration made less uncomfortable. Firm support of the lower ribs will aid this and not check it. Also opiates in reasonable amounts are a help in that they allow some movement without pain. (*b*) Posture. The sitting position with the patient fixed and not moving from side to side, or on one side only, obviously restricts abdominal and diaphragmatic movements, and limits the expansion of the lower lobes so that secretion will tend to stagnate in the tubes rather than be expelled, even when it is not very thick. The exaggerated Fowler's position certainly favours both atelectasis and thrombosis in

large veins, and some modification or at least some relaxation is needed. The patient should be encouraged to breathe deeply at intervals, and if he can be placed first on one side and then on the other from time to time during each day, the likelihood of the occurrence of atelectasis is greatly diminished.

If sputum is very thick, citrates and ammonium carbonate may help, but the patient is usually not in a condition for oral medication.

Adrenaline or atropine may help if there is bronchial spasm or excessive secretion, and atropine before anæsthesia has an undoubted value.

Treatment.

If atelectasis occurs, the best treatment is bronchoscopy in skilled hands, and in selected cases this would be invaluable in prophylaxis.

Merely turning the patient on to the unaffected side so that the movement of the involved lung is increased will sometimes suffice to aerate the collapsed area and to relieve the condition. Unfortunately the patient is less comfortable in this position, the pain may be greater and the feeling of breathlessness increased so that he may refuse to remain so placed for long, but the attempt should be repeated from time to time and combined with other measures such as the inhalation of carbon dioxide.

Carbon dioxide inhalation, as introduced by Henderson and his school, is certainly valuable. It may be a help when given immediately after operation to accelerate the removal of the anæsthetic by over-breathing and to insure full expansion of the lung, but is much more valuable during the next few days to insure full ventilation where this is not being obtained.

If it is administered for five minutes at a time three or four times a day, good respiratory excursion can usually be obtained with little or no pain even in patients who cannot voluntarily breathe deeply. It is better to use a strong mixture, 30%, or even pure carbon dioxide for a few breaths at a time if the patient is weak, as 5% or 10% in oxygen will only produce hyperventilation if given by some closed method. If the lower ribs are supported by the nurse's hands while the gas is being inhaled, pain can usually be controlled, especially if some morphine has been given.

Brown[6] has observed the effect of carbon dioxide inhalation in such cases by direct bronchoscopy, and has shown that it causes: (i) An increase in the rate and depth of breathing. (ii) By the increase in depth the walls of the bronchi are caused to approximate one another, and in this manner tend to free any secretion attached to the wall, or perhaps to cause a temporary occlusion which in itself would produce violent expiratory effort and thereby tend to expel the retained secretion. (iii) Blanching of the mucous membrane of the trachea and bronchi when a moderate concentration of carbon dioxide is administered.

It is not necessary that the whole of the obstructing mucus should be removed to allow of reaeration of a lobe or lobule. Provided that air

can pass between the mucus and the bronchial wall during inspiration, it will reinflate some portion of the lung; as more and more is inflated, cough will be more effective and so some mucus will be expelled into a larger tube and the process continued. As is well known in similar medical conditions, the collapsed areas in patchy atelectasis are not all reaerated simultaneously, but the aeration of some facilitates the expulsion or shifting of mucus in surrounding bronchi and so the whole area is gradually reexpanded. As I suggested earlier, there is little evidence that the anæsthetic is of great importance in the production of these pulmonary complications, and even in surgical writings they are now described as post-operative instead of, as formerly, post-anæsthetic.

Though it would seem that the excessive salivation and over-secretion which accompany an unsatisfactory ether administration would

TABLE III.

Site of Operation.	Inhalation Anæsthesia.			Subarachnoid Anæsthesia.		
	Cases.	Pulmonary Complications.	Percentage.	Cases.	Pulmonary Complications.	Percentage.
Abdominal	63	3	4·8	176	22	12·5
Lower extremity and perineum	172	0	0	151	3	2·0
Upper extremity head and neck	184	3	1·7	0	0	0
Torso	55	0	0	11	0	0
Total	474	6	1·3	338	25	7·4

make pulmonary complications more probable, there is no clear evidence that this is so, and, unless infective material is inhaled at the time, the coughing and retching which result from the administrative difficulties probably clear the tubes satisfactorily.

Pulmonary complications seem to be as common after chloroform as after ether, and have been shown to follow all types of anæsthesia, though it has been suggested that they are most frequent after spinal anæsthesia. For example, Brown and Debenham[7] give the figures shown in Table III.

Brown states that "poor risk" cases were given general rather than spinal anæsthesia.

Brown[8] has the impression that spinal anæsthesia predisposes to post-operative atelectasis because: (i) It definitely inhibits the respiratory movements not only during operation itself, but for a considerable time afterwards. It is these respiratory movements, both intrinsic and extrinsic, which tend to rid the tracheo-bronchial tree of foreign matter or secretion. (ii) The normal viscosity of the secretion appears to be increased, the material being more tenacious following spinal anæs-

thesia. (iii) Following spinal anæsthesia the patient tends to remain relatively quiet for hours.

H. W. Jones[9] also finds lung collapse frequent after spinal anæs-thesia, he thinks more than after inhalation anæsthesia. In any case, it is quite certain that spinal and local anæsthesia are no safeguard against post-operative pulmonary complications.

Post-Operative Abscess of the Lung.

Post-operative abscess of the lung is most common following throat and mouth operations, especially tonsillectomy and tooth extractions, and three methods have been suggested for its production: (i) Direct lymphatic spread from the infected area. (ii) Infected emboli carried to the lung by the blood stream. (iii) Aspiration of infected material which occludes a bronchus with the production of local collapse, a pneumonic condition, and then necrosis of the involved lung through the action of organisms carried in the aspirated material.

Of these, the first lacks any authoritative support and can be disregarded.

Embolism cannot be excluded as a possible cause in some cases. If infected clot separates from a vein in the operation area and lodges in the lung, it can surely produce an abscess.

I need only point out the striking frequency with which this seems to occur in tonsillar and dental operations compared with its rarity in operations on infected areas in the limbs. For example, Schlueter and Weidlein[10] reported 1,908 cases of abscess of the lung, of which 515, or 29·6%, were post-operative, and of these 268, or 14·6% of the entire group, followed tonsillectomy. This group certainly includes reports by authors who stressed tonsillectomy as the most frequent predisposing factor in post-operative abscess of the lung.

There is little doubt that the healthy lung can deal with quite a considerable infection carried by an embolus without showing evidence of abscess formation. Pulmonary abscesses certainly occur in cases of pyæmia, but are multiple, and in the post-operative cases the abscess, though ragged and apparently made up of communicating cavities, is localized to one area. Also experimentally produced embolic abscesses are usually parenchymatous, whereas clinically the abscess nearly always communicates direct with a bronchus.

It seems far more probable that these abscesses are caused by the aspiration of infected material. A bronchus is blocked and atelectasis follows, just as has been described previously, but there are noticeable differences.

The occluding material is not simply secretion which will naturally be found in the dependent parts of the lung, but is practically a soft foreign body and may be caught up anywhere, but quite likely in an upper bronchus. The material or part of it is blood clot, which is cleared from the bronchial tree only with difficulty, and if it becomes caught in a small bronchus, will adhere and cause collapse of the lobule.

If the clot or other material contains appropriate organisms, the collapsed area of lung becomes infected and the centre breaks down, forming an abscess which may be quite small and local, or the infective process may extend, more bronchi may be blocked by pressure or spreading inflammation, and the abscess may become quite large.

Later infection may be spread through the lobe or lung by aspiration of pus into other tubes, as occurs in pulmonary tuberculosis at times.

It has been pointed out as an argument against the aspiration theory that such pulmonary abscesses frequently follow tonsillectomy under local anæsthesia, but Ochsner and Nesbit[11] found that after tonsillectomy under local anæsthesia, if patients were given iodized oil with instructions to swallow it, the oil passed into the trachea and bronchi instead of into the œsophagus.

Myerson[12] examined 100 patients bronchoscopically immediately after tonsillectomy performed under light general anæsthesia. Twenty-two retained the cough reflex, and of these eighteen had no blood or mucus in the tracheo-bronchial tract, while four did. Seventy-eight had lost the cough reflex, but retained the laryngeal reflex, all but six of these showed blood or mucus in the tracheo-bronchial tree.

Thus it seems certain that the opportunity for the occlusion of bronchi with infected material must frequently be present, and the fact that such occlusion may result in the production of pulmonary abscess in the experimental animal has been demonstrated by Harkavy.[13]

The fact that severe symptoms often do not appear till a week or more after operation is not opposed to the aspiration theory, as if the damaged area of lung is small or the infection not virulent, symptoms may be slow in appearing, and may be slight or even resolve without breaking down of the affected area.

CONCLUSIONS.

1. Serious post-operative pulmonary complications are of two kinds: (a) Embolism, which may be caused by large clots carried from the great veins and resulting in rapid death, or smaller clots perhaps from the seat of operation, which cause infarction of the lung if sufficiently large. (b) Atelectasis, due to obstruction of bronchi by secretion or aspirated material. The importance of this depends on: (i) The size and number of obstructed tubes. (ii) The nature of the organisms in the obstructing material or tubes. (iii) The length of time the obstruction remains in the tubes.

2. The anæsthetic *per se* is of little importance in the ætiology.

3. These conditions are many times more frequent after abdominal operations than after operations on other parts of the body.

4. In the avoidance of these complications, a comfortable posture and frequent movement are important. Movement, deep breathing, and unrestricted coughing are of great value in avoiding bronchial obstruction, while the direct removal of the obstruction through the bronchoscope may prevent or cure the condition.

5. Immobility in Fowler's position, which entails a double kink in the great veins from the lower limbs as well as a relatively dependent position of these limbs, aids in the production of thrombosis in the veins and therefore of pulmonary embolism.

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POST-OPERATIVE PULMONARY COMPLICATIONS.

By GILBERT BROWN,
Adelaide.

UNTIL recently the anæsthetist was generally a mere underling detailed by the surgeon to "give ether" to a patient whom he had not seen before entering the theatre and whom he was not expected to see again after the conclusion of the operation. Gradually the work of the anæsthetist has increased in scope as it has been realized that a conscientious anæsthetist is concerned not only with the life of the patient during operation, but with his comfort, health and safety both before and after operation.

It is now recognized that the success of an operation does not depend entirely upon the skill of the surgeon, but is determined in some part by the skill and wholehearted co-operation of the members of the team who make up the surgical unit. The incidence of post-operative pulmonary complications may be reduced and the number of deaths lessened by the practice of a wider application of the art of anæsthesia in the following manner.

The duties of the anæsthetist of today are not limited to the act of rendering the patient unconscious of pain during surgical manipulations. Risk of post-operative pulmonary complications may arise from conditions existing in the patient prior to operative procedure, to conditions arising during the operation, and to events taking place after the patient has left the theatre. Analysis of the results of a large series of operations has shown that the most important factors in post-operative pulmonary complications are the condition of the patient before operation, the type of operation and the post-operative treatment. Factors of less importance are the pre-operative preparation, the type of anæsthesia and the premedication.

The duties of the anæsthetist should include a thorough examination of the patient, preferably on the night before operation. This may be facilitated if the surgeon instructs his patients to enter hospital before 7 p.m. Special attention should be paid to the past history of lung disease and to the effect of previous anæsthetics as regards lung complications. The presence of a cold or a recent attack of bronchitis should be regarded with suspicion, as patients so affected provide a very high percentage of lung complications. In a recent survey of 833 anæsthetic administrations I found fifteen cases of post-operative pulmonary complications with three deaths; of these fifteen patients ten had some respiratory affection at the time of operation, or had suffered from one shortly beforehand. If possible, the operation should be postponed, but if this is inexpedient, it is better to avoid ether as the anæsthetic and the use of the barbiturates for premedication.

An attempt should be made to grade the patients according to their operative risk, as it is in the lower grades that the greatest number of complications occur. In order to do this more accurately, advantage may be taken of several simple tests.

The Breath Holding Test.—The patient sits perfectly quiet for five minutes, then draws a full, but not abnormally deep, inspiration. The breath is then held with the mouth closed and the nostrils compressed with the fingers, while the time is noted. The normal period for which the breath can be held in this manner is 30 to 40 seconds. If the time is under ten seconds, the patient is unfit for any general anæsthetic; if between ten and eighteen seconds he is a poor risk, though possibly fit for a short gaseous anæsthetic. If the breath can be held from eighteen to thirty seconds, he is a fair risk. Periods over thirty seconds probably indicate a good risk.

Pressure Ratio (Moot's Rule).—The pressure ratio, which is a fraction having the pulse pressure as numerator and the diastolic blood pressure as denominator, may be normal between 40% and 60%. If the ratio is either higher or lower there is reason to apprehend danger. If the ratio lies between 25% and 75% the condition is probably operable; if outside these limits it is probably inoperable.

Energy Index.—Barach has applied the term "energy index" to the amount of energy expended by the cardio-vascular system in one minute. It is arrived at by multiplying the sum of the diastolic and systolic blood pressures by the pulse rate. The normal range for this figure is 13,000 to 20,000.

During this examination consideration should be given to the type and amount of premedication and to the choice of anæsthetic for existing conditions. Premedication may have some definite influence on post-operative pulmonary complications. Basal narcosis appears to be followed by a higher percentage of such complications than premedication which is sufficient to alleviate fear, but which still leaves the patient able to answer questions on coming into the operating theatre. In the presence of respiratory infections and in upper abdominal operations the dose of prenarcotic should be small.

CHOICE OF THE ANÆSTHETIC.

Until recent years the anæsthetic has usually been blamed for post-operative pulmonary complications. It has been found, however, that the so-called "ether pneumonia" is not pneumonia, and that the ether has little, if any, influence in its production. In a recent research by King, of the Massachusetts General Hospital, it has been shown that pulmonary complications following ether were actually less than those following spinal and local analgesia. Ether is still the commonest anæsthetic used in Australia, although its irritating action on the respiratory mucous membrane is well known. Cases are on record of its use being followed by acute pulmonary tuberculosis from a quiescent focus; I have seen this complication occur within fourteen days from the time of operation. Anæsthesia induced by the endotracheal method has been criticized by some surgeons, who have suggested that by passing

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a tube through the mouth or nose into the trachea there is danger of carrying infection from them into the lungs. However, this type of anæsthesia has been used many thousands of times without any evidence that this occurs.

When lung disease is present it is wiser to avoid ether or the ether-chloroform mixtures. Nitrous oxide and oxygen, or ethylene and oxygen are then the anæsthetics of choice, as they have no irritating action on the lungs, and they give a greater margin of safety. In some upper abdominal operations it may be difficult to obtain proper muscular relaxation with them unless a field block is also used. The gaseous anæsthetics permit operations to be performed with safety upon patients who are handicapped by pulmonary tuberculosis or other lung disease. Unfortunately, their cost is high and economic reasons may prevent their use in some of these patients and recourse may have to be made to chloroform.

PREPARATION OF THE PATIENT.

The preparation should be planned so as to interfere as little as possible with the comfort of the patient. It should be completed by 9 p.m. on the evening before operation, unless there is any special reason to the contrary. A sedative should then be given and the patient allowed to sleep until next morning.

I recently gave an anæsthetic for a patient who had been given castor oil on the previous night and was then awakened at 4.30 a.m. and given an enema, two bowel "washouts" and a vaginal douche as preparation for a simple supra-vaginal hysterectomy. It was most striking to observe this tired, dehydrated and nervy patient who came into the operating theatre blue and cold.

CARE DURING THE OPERATION.

Too little attention has been given to the minor points which tend to the production of shock and pulmonary complications. The operating theatre should be at a temperature of 21·0° to 23·8° C. (70° to 75° F.), and the operating table should be efficiently padded and warm. Anæsthesia should be as light as is consistent with the surgical procedure. A blood pressure chart should be made in all long operations likely to produce shock, as by this means it is possible to give the surgeon warning of its approach. The patient who is allowed to become seriously shocked is more likely to have pulmonary complications. McKesson has shown that after half an hour of sustained low blood pressure and rapid pulse almost every patient succumbs within the next three days. His definition of shock is progressively increasing pulse rate above 100, with progressively falling systolic blood pressure of 80 millimetres or less and 20 or less pulse pressure for more than twenty minutes. Here a vicious circle comes into play. The prolonged hypotension leads to suboxygenation of the body tissues and a capillary stasis. The capillary stasis reduces the amount of circulating fluid and the suboxygenation of the tissues results in the appearance of various toxic products from imperfect tissue metabolism. All of these collectively reduce the blood pressure still more, and so the vicious circle goes on.

This will continue to a fatal issue unless some link in the chain is broken and the error in the blood pressure overcome. Miller records a death rate of over 69% among those patients who were in this danger zone for over thirty minutes. If such patients live for two or three days there is found to be a definite involvement of the bases of the lungs.

The anæsthetic should be withdrawn before the end of the operation whenever possible, so that the anæsthetic may be excreted quickly and the cough reflex be present before the patient leaves the theatre. In all upper abdominal operations "Carbogen" should be administered for five minutes at the end of operation and for periods of three minutes every three hours for the first twenty-four or forty-eight hours. This aids in the expansion of the bases of the lungs and tends to prevent collapse.

AFTER-TREATMENT.

Post-operative pulmonary complications may be produced or prevented in a great measure by the after-treatment of the patient. After leaving a warm operating theatre, the patient must be adequately protected from cold corridors and be placed in a warm bed in a warm room. The anæsthetist personally should conduct the patient back to bed, see that the transport is efficient and that the nurse in charge understands the orders for position and treatment of the patient. He should also inform the surgeon of the patient's condition and make suggestions for his safety or comfort. He should visit the patient afterwards, so that he may see the effect of the anæsthetic and operation, and thus increase his experience, and collaborate with the surgeon in the after-treatment. The nursing of the patient should include frequent changes of position, the early administration of fluids and attention to comfort, so that breathing may be easy and full. In cases of respiratory depression it may be wise to administer "Coramine" in full doses by the intravenous or intramuscular method. Signs of collapse of the bases of the lungs should be treated by inhalation of "Carbogen" through a nasal catheter. It is interesting to note that though it is painful for the patient to take a natural deep breath, yet the deep breathing induced by "Carbogen" is not painful and is often welcomed by the patient. Bronchoscopic suction, in order to remove secretion which may be blocking the smaller bronchi, is warmly advocated by the Chevalier Jackson school. If this is not available, a mixture should be administered which contains a small dose of apomorphine hydrochloride 1·3 to 1·8 milligrammes (one forty-eighth to one thirty-sixth of a grain) every four hours, so that the secretion may be eliminated more easily.

CONCLUSION.

I hope that I have been able to show, by these remarks, how the surgeon may be assisted in his work, be relieved of considerable anxiety, and may be enabled to share his responsibility by a more liberal use of the anæsthetist. And how, by attention to the details described, the incidence and severity of post-operative pulmonary complications may be reduced.

POST-OPERATIVE PULMONARY COMPLICATIONS.

By Raymond Hennessy,

Melbourne.

On account of the fact that he is constantly operating in the upper food and air passages, it is not inappropriate that a laryngologist should be asked to discuss post-operative pulmonary complications. The propinquity of the site of operation to the lungs naturally requires special precautions to be taken, and modifications of anæsthetic and of operative technique become necessary.

At the outset one may observe that in the majority of cases treatment of lung complications is not very satisfactory, and therefore all possible precautions to prevent their occurrence deserve the closest consideration.

Dr. Turnbull has observed that the kind of anæsthetic and the method of anæsthesia are not now regarded to be so important as the operation itself in causing post-operative lung complications, and I agree in the main with this. Nevertheless, in nose and throat operations the anæsthetic looms largely and may be considered an integral part of the operation itself; therefore, in my opinion it becomes largely the surgeon's problem. It requires careful planning to maintain anæsthesia without interruption for prolonged periods during operations in the air passages.

I would consider post-operative lung complications of these operations as under two headings: (i) those peculiar to operations on the nose, mouth and pharynx, for example, due to inhalation of foreign bodies, blood clots, or septic secretions; (ii) those common to all operations, for example, due to metastatic infection from the wound.

I propose now to consider the anæsthetic and the circumstances of its administration. It will be acknowledged that in nose, throat and mouth operations some mechanical contrivance is necessary to maintain continuous anæsthesia. Operating on patients between their gasps or while they are oscillating between deep and light anæsthesia is no longer tolerable. Anæsthesia, therefore, is maintained either by intrapharyngeal or the intratracheal method.

I am strongly in favour of the intrapharyngeal method for routine operations in the mouth, nose and pharynx. The apparatus required is simpler, and I believe that this method of anæsthesia is less dangerous and less likely to be followed by lung complications than the intratracheal method. It is, moreover, equally efficient. It is my opinion that to place and to retain a catheter in the trachea, however skilfully, adds to the risk of lung complications. Teeth are liable to be damaged

or knocked out and pieces broken off may be inhaled. The catheter may become contaminated in passing through a septic mouth or nose to the less immune tracheal or even bronchial mucosa. The suggestion that the intratracheally placed catheter makes gravitation or insufflation of foreign bodies or secretions into the lungs impossible is a canard and believed only by the credulous. On the contrary, having to make provision for the escape of the return flow of air around the catheter prohibits packing off of the pharynx, which is the only certain safeguard.

Surgical emphysema arising from the mediastinum to the neck and head is always possible with anæsthesia induced by the intratracheal method. There is an idea abroad that this is due to development of high pressure in the anæsthetic apparatus or to the calibre of the catheter being too large. I consider it more probable that the catheter is inadvertently passed too low, and, entering the right bronchus, makes a snug fit in the diminished lumen and interferes with the return flow of air. In the three cases I have observed the emphysema first appeared on the right side. This complication is more liable to occur in little children, and is a regrettable and dangerous lung complication and, of course, due entirely to the anæsthetic.

It has been suggested that warming of the anæsthetic vapour may be an important factor in preventing post-operative pneumonia. It is amusing to observe that the usual method of warming the ether vapour defeats the very object which was intended. A moment's reflection will show that on account of the discrepancy between the specific heat of water (one of the highest of any substance known) and of ether gas the effect of warming the ether vapour is to dry it and as a result the patient inhales dry hot ether vapour. The desiccating and irritating effect of this on the mucous membrane of the trachea is easily understood in considering the respiratory discomfort experienced on a hot north wind day.

Except in those cases in which there has been evidence of inhalation of overt foreign bodies, I believe that most lung complications seen after mouth, nose and throat operations are due to embolic infection from the wound. The nature of the wound left after these operations must be very conducive to this. You have to consider that all these wounds heal by the second intention, and that there is necessarily a heavy bacterial contamination, though no doubt of low grade pathogenicity.

In my experience, by far the greater part of lung complications occur during the second week after operation. This coincides with the time when secondary hæmorrhages occur—a not uncommon and most unpleasant complication of nose and throat operations. I regard these hæmorrhages as evidence of intravascular sepsis and that the wound is open to the general circulation. Not infrequently the patient is home by this time. He develops a slight dry irritating cough, a bad taste in the mouth and a bad odour of the breâth. Commonly there is a slight fever, about 37·8° C. (100° F.), with weariness and lassitude. The patient and his relatives usually attribute the symptoms to a cold caught on leaving the hospital. In the cases that I have observed these

symptoms persist more or less for three or four weeks, the expectoration becoming more offensive and almost fæculant in odour; nevertheless, complete recovery is the rule.   In other cases the sputum is frankly purulent.   Hæmoptysis has occasionally been observed as an inaugural symptom.   I regard these symptoms as being due to showers of small emboli reaching the lung and perhaps causing small infarcts. Sometimes small areas like infarcts can be seen by radiography.   I have presumed that the characteristic offensive odour of the sputum and breath is due to the preponderance of putrefactive organisms in the emboli corresponding with the predominating bacterial flora of wounds in the mouth, nose or throat.

Frank lung abscess is a common complication in North America and Canada after tonsillectomy, where, curiously enough, the operation in adults is almost invariably performed under local analgesia.   This would seem to take a lot of explaining away by those who would uphold the inhalation as opposed to the embolic theory of infection.

Massive collapse and lobar collapse of the lungs due to inspissation of mucous secretions, as recently suggested by the Philadelphia school of laryngologists, is an attractive explanation of post-operative pneumonias not necessarily nor particularly following nose and throat operations.   I know of the condition only by hearsay.

To avoid lung complications in nose and throat surgery it is essential to see that no foreign bodies, blood or septic secretion reach the lung during the operation.   This is obtained by packing off the wound as in abdominal operations; by posturing the patient so that gravity is helpful, and by the use of suction apparatus.   In all nasal operations under general anæsthesia a post-nasal plug is indispensable.

Carnivorous surgery is to be avoided as much as possible in order to reduce unnecessary sepsis from the wound.   In operations such as tonsillectomy, for instance, it is better to avoid a large vein than to cut it and so open up the venous circulation to the wound.   After nasal operations it is better to avoid packing the nose.   Care of the patient during recovery from the anæsthetic is most important, and it is my custom to detain the patient on the table in a suitable head-low position until the swallowing and laryngeal reflexes have obviously returned.

DUODENAL FISTULA AND ITS MANAGEMENT.

By Victor Hurley,
Melbourne.

External duodenal fistula is fortunately not very frequently met with. It is a most serious condition, and threatens the patient's life owing to the rapid deterioration which occurs in his condition.

In 1923 Cameron[1] collected 30 cases from the literature with 12 deaths. In 1924 Rigby[2] recorded seven cases (all the patients recovered) which had occurred at the London Hospital in the previous twenty years.

The ætiology of the condition in Cameron's series was as follows:

		Cases.	
1. Following operations on the duodenum—			
(a) Perforated ulcer	.. ..	6	
(b) Traumatic rupture	.. ..	5	
(c) Gall stone in common bile duct	.. .. ..	1	
(d) Carcinoma of pancreas	.. ..	1	
		—	13
2. Following operations on the gall bladder	.. ..	6	
3. Following operations on the kidney	.. .. ..	7	
4. Following operations on the stomach	.. .. ..	2	
5. Following abscess in the loin	.. ..	1	
6. Cause uncertain	.. ..	1	
		—	17
			30

In Rigby's seven cases the causes were as follows:

		Cases.	
Following operation on the duodenum—			
(a) Perforated ulcer	.. ..	1	
(b) Traumatic rupture	.. ..	1	
(c) Acute diverticulitis	.. ..	1	
		—	3
Following operation on the kidney	.. ..	1	
Following operation on the stomach	.. .. ..	2	
Following operation for appendix abscess	.. ..	1	
		—	4
			7

One of the two cases reported herewith followed a severe crushing injury of the right kidney with probable involvement of the duodenum and pancreas in addition; and the other followed an operation for empyema of the gall bladder in which infection had spread beyond the gall bladder and formed an abscess involving the adjacent viscera.

CASE HISTORIES.

CASE I. *Traumatic Rupture of Right Kidney; Perirenal Hæmatoma; Probable Crushing of Colon, Duodenum and Pancreas; Duodenal Fistula.*—K.W., a railway porter, aged nineteen years, was admitted to the Melbourne Hospital on February 13, 1920. Five hours previously he had been crushed between railway trucks while engaged in shunting operations at Dandenong. He had been given 0·015 gramme (a quarter of a grain) of morphine, and there had not been any bowel or urinary action between the time of his accident and his admission to hospital. He had vomited once.

On admission to hospital he complained of pain about the right lower part of the chest and over the right side of the abdomen where he had been crushed, and over these regions there were scattered bruises and abrasions. He was pale and shocked. His temperature was 36·4° C. (97·6° F.), his pulse rate was 88. There was no evidence of fractured ribs. There was marked tenderness and rigidity over the right side of the abdomen and over the right kidney region posteriorly, where a deep-seated swelling could be vaguely outlined. Dulness was present on percussion in the right flank, but there was no apparent diminution of the normal liver dulness.

On passing a catheter, grossly blood stained urine was obtained, and a bowel action also yielded much bright blood.

It was therefore evident that the right kidney was severely damaged and also the intestine—probably the right side of colon; there was also the possibility of injury to the other viscera which had been in the line of the crushing force.

Operation was carried out. The abdomen was opened through a right paramedian incision. There was much bruising of the deeper layers of the abdominal wall, and on opening the peritoneum several small blood clots escaped. The transverse colon was much bruised and œdematous. The liver, gall bladder and stomach were normal. There was a large retroperitoneal hæmatoma surrounding the right kidney, obscuring its outline and extending upwards and towards the mid-line in the region of the duodenum and pancreas. No rupture of any of the hollow viscera was detected. The damaged right kidney was not interfered with, and the abdomen was closed.

For the next four days the patient's condition steadily improved, but he continued to pass blood and clots in the urine, some specimens appearing to be almost pure blood.

On the fifth day there was a considerable increase in the amount of blood passed (possibly secondary renal hæmorrhage), and the patient had much pain and difficulty in passing urine. The bladder was distended, and on passing catheters these were blocked by blood clot which could not be dislodged by irrigation.

Clot retention was evidently present, and suprapubic cystotomy was carried out. The bladder was found filled with clot, which formed a complete cast of its interior. This was removed. There was no bleeding from the bladder itself. A large rubber tube was inserted and the incision in the bladder was sutured round the tube. For the next few days the patient did well, passing urine mixed with blood *per urethram*, as well as draining freely from the suprapubic tube. During these days his temperature was round about 37·8° C. (100° F.) and his pulse rate 100 to 108.

On February 26, 1920 (thirteen days after his injury), he had a rigor, with a temperature of 40·5° C. (105° F.) and pulse rate 132, and the following day another rigor with temperature 40·7° C. (105·4° F.) and pulse rate 176. A pleural rub was detected at the right base, and there was also increased swelling and tenderness in the right loin. By March 3, 1920 (eighteen days after injury), definite signs of infection of the large hæmatoma in the right loin were present, and this was opened. Much breaking down infected blood clot mixed with urine was evacuated. The wound was lightly packed with gauze and drained. No attempt was made to determine the extent of the damage to the right kidney.

The patient's condition improved somewhat for the next few days, although he ran a temperature and had evidence of continuing infection. On March 19,

1920 (five weeks after his accident), it was noted that fluid and undigested food were escaping from the wound in the right loin. Easily recognizable foods, such as raspberry jam and boiled egg, appeared in the loin a few seconds after they were swallowed. The escaping fluid was acid in reaction, and, so far as could be determined, practically all food and fluids by the mouth escaped from the wound. The patient had a voracious appetite and thirst, but lost weight and strength with alarming rapidity. A dramatic change occurred in the appearance of the wound, the offensive breaking down clot and *débris* which had resisted the usual local irrigations, was rapidly digested, leaving a raw red granulating wound. At the same time, the signs of infection began to subside, and the temperature and pulse rate diminished. Saline solution with glucose given by the rectum was pushed. Intense irritation of the skin around the wound occurred, though it was protected as far as possible by boroglyceride, ambrine and dressings of serum and alkaline solutions. The duodenal fistula continued for three weeks, during which time the patient lost nearly 18·9 kilograms (three stone) in weight, and became so weak and emaciated that it seemed likely he would die of inanition. Then quite suddenly the wound healed about April 12, 1920, and with the exception of a slight further discharge a few days later, he made a rapid recovery. He regained in two or three weeks the weight he had lost, his suprapubic wound healed satisfactorily, and he was discharged on June 22, 1920.

He was seen at intervals at his job on the railways during the next few years and remained well and free of symptoms. Before he left hospital an X ray and opaque meal examination was carried out; this showed some duodenal arrest only; there was no gross stasis and no evidence of the site of the fistula.

CASE II. *Recurrent Cholecystitis; Empyema of Gall Bladder with Perforation and Abscess; Cholecystostomy; Duodenal Fistula.*—Mrs. C., aged twenty-seven years, was first seen in consultation on April 13, 1932, and gave the following history. Six years previously she had an acute cholecystitis; at operation several gall stones were removed and the gall bladder was drained. Except for flatulent dyspepsia, she was well until three weeks ago, when another acute attack occurred. A day or two later a physician who saw her regarded the attack as a severe one, and advised operation. Her pain and acute symptoms, however, became somewhat easier during the next few days, and this advice was not acted on for three weeks. Thirty-six hours before the patient was seen in consultation there was a recurrence of very acute pain, and a mass could be felt in the region of the gall bladder.

On examination the temperature and pulse rate were not markedly increased. There was no jaundice. The urine was normal. Beneath a Mayo-Robson scar of her previous operation a large tender mass could be felt. Operation was advised and carried out on the following morning. Kocher's incision was used, and many recent and old adhesions were encountered on opening the abdomen. The liver, colon, stomach and duodenum were firmly adherent to each other and to the anterior abdominal wall. As these adhesions were cautiously separated an abscess between the gall bladder and colon was opened into. When this was cleared away a sloughing gall bladder was exposed lying well back on the inferior surface of the liver. On opening this, more pus and mucus escaped, but no bile, and a round smooth stone impacted in the cystic duct was removed. Formal cholecystectomy was not attempted, but most of the necrotic gall bladder was removed and to the interior of the remainder pure carbolic acid was applied. A rubber drain tube and iodoform gauze packing were inserted; the abscess cavity outside the gall bladder was also drained. The patient's condition at the conclusion of the operation was good. The tube in the abscess cavity was removed on the third day, and the tube and gauze in the gall bladder were shortened, both being finally removed on the seventh day. Some bile drained from the wound from the second day onwards. The patient's condition was good, and the temperature and pulse rate were practically normal for the first week. On the eighth day after operation it was noted that a high intestinal fistula was present. Acid discharges and food were present on the dressings, and the amount of bile drainage was

much increased. As in the previous case, easily recognizable food appeared in the wound a few seconds after being taken by the mouth. The wound rapidly became extremely painful and the surrounding skin excoriated, despite attempts to protect it. The pulse rate steadily increased in rate to 104 and later to 120 per minute, and was of poor quality. The quantity of urine rapidly fell to 300 to 360 cubic centimetres (ten to twelve ounces) daily and the tongue was dry, red and glazed. The patient rapidly lost weight and strength, and her condition gave rise to much anxiety. So far as could be judged, all fluids given by mouth escaped through the fistula. Fluids given by the rectum were obviously insufficient to meet her needs, and large quantities of dextrose (5%) saline solution were given subcutaneously in quantities of 2,400 to 3,600 cubic centimetres (four to six pints) daily for a week, the needles being left in position. The general condition definitely showed evidence of improvement from the time of the absorption of the subcutaneous fluid in large quantities. The fistula lasted for ten to twelve days and then closed. Her lost weight and strength were rapidly regained, and she made a good recovery, leaving hospital seven weeks after operation. When last seen some months later, she seemed and felt quite well.

DIAGNOSIS.

In most cases diagnosis is readily made by the escape of characteristic duodenal contents. Sometimes, especially at the onset, there may be doubt, if the discharge is small in amount, or there is no recognizable food or marked evidence of irritation or excoriation of the wound. There is usually some bile in the discharge. In one of Rigby's cases it is stated that the reaction of the discharge was alkaline, but in the first case here reported it was acid. The highly irritating and destructive action of the fluid is largely due to the contained trypsin, which is active in neutral as well as in slightly acid or markedly alkaline solutions (Howell).[3]

CLINICAL COURSE.

The clinical course varies with the size of the fistula. When the opening is minute and the discharge small in quantity, as in some recorded cases, the patient's condition is not seriously affected, but such cases are most unusual.

Russell Howard's[4] case, in which a duodenal fistula persisted intermittently for eleven years, and was then closed by operation, is probably unique. The usual type is that in which the discharge is large in amount and destructive, rapidly threatening life. The time of appearance of the fistula is usually in the first week or so, but it may not be for several weeks (five in Case II).

Pannett[5] in 1914 stated that as far as could be ascertained from writings of the previous ten years, a duodenal fistula never healed without surgical aid and, if left, was invariably fatal. W. J. Mayo[6] stated that in those cases due to injury of the duodenum in performing nephrectomy, death would often, if not usually, occur. McGuire,[7] Hendon,[8] and Einhorn[9] also emphasize the gravity of the prognosis.

It is difficult to measure the quantity of the fluid lost unless some form of suction apparatus is employed; quantities from 700 to 4,000 cubic centimetres daily have been recorded.

The chief factors concerned in the production of the clinical picture are: (i) loss of fluid with dehydration of the tissues: (ii) loss of acid and chlorides of the gastric secretion; (iii) the digestive action on the wound by the pancreatic secretion, particularly trypsin; (iv) loss of bile—this is not constant, particularly if the fistula is proximal to the ampulla of Vater.

Death is usually ascribed to exhaustion and emaciation from the great loss of fluid, to peritonitis, and to a condition of toxæmia described by Kanavel[10] as occurring in rupture of the duodenum, and this seems to be related to the loss of acid and chlorides from the body. Walters and Bollman[11] have investigated this aspect of the condition. The loss of acid turns the tide of blood neutrality strongly towards alkalinity and the loss of chlorides reduces the blood chlorides from a minimum normal of 560 milligrammes to as low as 320. As the blood chlorides diminish the blood urea rapidly increases.

In a fatal case which developed a duodenal fistula after an extensive Pólya resection of the stomach, the blood chlorides before operation were present in a quantity of 522 milligrammes per 100 cubic centimetres, and urea 21 milligrammes per 100 cubic centimetres. Subsequent to the development of the fistula the chlorides dropped to 327 milligrammes and the blood urea rose to 84 milligrammes. Similar findings were found to be present in experimental animals in whom a duodenal fistula was established. The increase in the blood urea is associated with the development of a toxic nephritis preventing elimination of urea, and to a less extent may be due to increased breaking down of the body tissues.

Walters and Bollman established the important fact that this toxæmia can be controlled by replacing the blood chlorides either by intravenous or subcutaneous administration of sodium chloride, so that the normal concentration of chlorides in the blood is restored and maintained. Other solutions, such as sodium sulphate or glucose, do not affect the blood chloride position, although they may decrease the urea through diuresis. In their fatal case referred to above the patient was not treated with sodium chloride injections, but in a later case of duodenal fistula which showed similar blood changes the patient was so treated, the toxæmia was controlled and the patient made a good recovery.

TREATMENT.

The aim of treatment in the first instance should be the spontaneous closure of the opening in the duodenum by correction of the various unfavourable factors. Only when these fail should operation be considered.

Local Treatment.

The irritant discharge should be prevented from coming into contact with the tissues. This is best attained by the use of a continuous suction apparatus as in Cameron's case, and as sometimes employed after prostatectomy.

The skin edges should be protected. This can be done by: (i) zinc oxide and castor oil or similar ointment, (ii) ambrine or paraffin, (iii) horse serum dressings, (iv) acid or alkaline solutions.

In Cameron's series he was struck by the frequency with which gauze packing had been used in those cases which developed fistulæ, and he strongly advised against its use; at any rate it is certain that where gauze has been used it should be removed as soon as possible—within twenty-four or at the most forty-eight hours of operation.

General Treatment.

Administration of Fluids.—It is usually advised that fluids by the mouth should be withheld so as to curtail the secretion of digestive ferments, to limit the discharge, and to lessen the movements of the duodenum. So long as a suction apparatus is employed there can be little valid objection to giving fluids freely. These patients suffer tortures of thirst, have dry, glazed tongues, and also absorb a certain amount from the stomach. Any advantage gained in the lessened movements of the duodenum by withholding fluids is more than offset by attempting to satisfy in part the patient's craving for fluid.

Injections of fluid into the rectum, usually water or saline solution and dextrose, are not sufficient to meet the body's needs for fluid, but should be pushed to the limit of the bowel's absorptive capacity. The extent to which saline solution or dextrose is absorbed in this way is still a matter about which much difference of opinion exists.

For the reason already stated subcutaneous and intravenous injections are of the utmost value, particularly chloride in the form of normal saline solution to which dextrose may be added with advantage. If subcutaneous injection is used, the strength of the dextrose solution should not exceed 5%. Scrupulous care should be taken to guard against infection when subcutaneous needles are left in position for several days as they were in Case II herein reported.

Continuous intravenous injection requires more supervision and imposes more restrictions on the patient, but is most valuable as an additional way of giving the essential fluid and chlorides.

Surgical Treatment.

If in spite of these measures the patient's condition steadily, and perhaps rapidly, deteriorates, it is a matter of great difficulty to decide whether operation should be carried out and, if so, when. The number of cases seen by any one individual surgeon is not sufficient to enable a dogmatic opinion to be given. The procedures which have been suggested are:

1. *Direct Attack by Suturing the Defect.*—The technical difficulties of suturing the defect are great, the patient's condition is not good enough to stand a long operation, and in most cases in which suture has been carried out, the sutures have given way sooner or later. W. J.

Mayo had one successful case in which a duodenal fistula following nephrectomy was closed as soon as it was observed.

2. *Indirect Methods.*—Indirect methods aim at enabling the patient to receive fluids while healing of the fistula is still attempted by continuing the general procedures already outlined. Gastro-enterostomy with pyloric occlusion (Berg)[12] and jejunostomy are used.

Gastro-enterostomy alone is unsuccessful because the stomach continues to pass some of its contents via the pylorus. If combined with occlusion of the pylorus, it aims at cutting off the discharge of stomach contents into the duodenum and removing the stimuli which encourage the flow of pancreatic secretion and bile. The patient can be fed by mouth within a few hours of operation. The disadvantages of the operation are: (*a*) In a greatly exhausted patient who has usually already had one operation, it is a severe and often difficult procedure. (*b*) It may not succeed, and is of no use in those cases following a Pólya or Billroth II resection, because in these the same conditions are present as Berg's operation accomplishes, and the fistula may continue or increase. (*c*) The undesirability of a short circuiting operation on a normal stomach.

Jejunostomy is a much simpler procedure, can be performed under local anæsthetic—away from the seat of the trouble and the previous operation wound which is excoriated and inflamed. With good technique the jejunostomy should close spontaneously when no longer needed. The patient can be immediately fed.

CONCLUSIONS.

1. Duodenal fistula, although a serious complication, will often heal spontaneously.

2. Local and general treatment require: (*a*) continuous aspiration of the discharges by the use of a suction apparatus, (*b*) protection of the wound, (*c*) maintenance of body fluids and chlorides.

3. If these do not succeed, jejunostomy and continuance of ample fluid and chloride administration should be carried out.

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VENTRICULOGRAPHY IN THE DIAGNOSIS OF INTRACRANIAL TUMOUR.[1]

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The subject of this paper will be discussed from the point of view of: (i) the indications, (ii) the interpretations, (iii) the information which can reasonably be expected from ventriculography.

Time will not permit any mention of methods of surgical or radiological technique.

INDICATIONS.

Percival Bailey, in a recent book reviewing his experiences with intracranial tumours, states that not less than 85% of such tumours are capable of clinical diagnosis and clinical localization. It is an unhappy fact, and one much to be deplored, that here at least we have a long way to go before we reach that degree of clinical acumen and accuracy.

During the last three years I have endeavoured to deal with 46 patients, all of whom showed signs of gross increase of intracranial tension. Of this number, 32 cases were capable of accurate localization by routine clinical examination. In the remaining 14 cases no localizing signs were recognized. This is a fit moment in which to discuss the interpretation of the term "localizing sign". Various observers had opinions and hunches as to the site of these 14 tumours; but, except in the hands of an expert, a hunch or a pious opinion is not to be regarded as sufficient reason for the exploration of any one particular part of the brain. It is one thing for a physician to have a strong feeling as to the site of a tumour; it is a very different thing for the neurological surgeon to regard a tumour as localized, as he must be prepared to follow up his opinion by a particularly placed craniotomy, an operation which even at the present day is not to be lightly undertaken. And therefore when it is stated that no localizing signs were recognized in these 14 cases, it is meant that, although various and contradictory signs were elicited by routine clinical examination, yet in no case did they enable one to make a diagnosis which would justify craniotomy without further methods of investigation. Undoubtedly a fuller experience will enable one to make a better interpretation of such signs as

are elicited; but until that experience has been gained it is unwise to subject a patient to an exploratory craniotomy until all avenues of investigation have been exhausted. It is scarcely necessary to add that the procedure of ventriculography is justifiable only after repeated clinical examinations have failed to further the localization of a tumour, or in those cases in which cerebral œdema has so obscured the patient's intelligence that examination of the whole sensory system is impossible or unreliable or when the available physical signs are too contradictory to support a diagnosis.

In cases such as the 14 above referred to, it is possible that in course of time further and more valuable signs would have appeared; but in my opinion the presence of signs of gross increase of intracranial tension demands early intervention, and I consider that the results quoted later in this paper fully justified the early use of a procedure which admittedly is by no means free of risks.

However, I think it is wrong to expect to gain too much information from ventriculography; absolutely reliable information will be obtained only in cases which show some gross abnormality in shape or size of the ventricles. In certain American clinics reports are made of diagnoses based on the most minute deformities of the ventricles. To go as far as this, one would have to be certain that the fluid in the whole ventricular system had been replaced by air, and this I believe to be well nigh impossible and certainly dangerous; and also, in the case of incomplete replacement, one must allow for uneven distribution of the air in the various portions of the ventricular system. There is no one posture of the head that will permit the air to distend all the ventricles during the taking of an X ray photograph; but by taking photographs with the head in various postures it is possible, after what is only a partial replacement of cerebro-spinal fluid by air, to outline one by one the various cavities of the brain. And for these and other reasons the person best fitted to draw deductions from a ventriculogram is the person who suspects the site of the tumour, who knows the conditions of fluid pressure and the quantity found at the time of puncture, and who knows how much air has been introduced; in other words, the neurological surgeon. And so far as my own experience is concerned, the only conclusions that have been drawn from this procedure have been based on the presence of some gross abnormality; and I believe that this is all that one can expect.

INTERPRETATIONS.

Brief reference will here be made to the interpretation of the findings disclosed during performance of ventriculography, and they will be referred to more fully during the description of illustrative cases at the conclusion of the paper.

Conclusions Which May be Drawn During Ventricular Puncture.

The Depth of Puncture.—In patients above the age of fifteen or sixteen years, in whom the ventricles are punctured at the vestibule by

means of the posterior approach, the ventricle is reached at a depth of not less than six centimetres from the *dura mater*. Should the ventricle be reached at a depth of five centimetres or less, it is strong presumptive evidence of the presence of either an enlarged or displaced ventricle. Should both ventricles be reached at such a short depth, it is strongly suspicious of the generalized ventricular dilatation found with sub-tentorial lesions.

The Quantity of Fluid Available.—The capacity of each lateral ventricle is estimated at between fifteen and twenty-five cubic centimetres of fluid; to be on the safe side, if the available fluid measures forty cubic centimetres or more, it is reasonable evidence of dilatation of that ventricle.

The Pressure of the Fluid.—It occasionally is found that a ventricle contains an abnormally large quantity of fluid, which is not, however, under increased tension. This condition is met with in certain cases of cerebral atrophy associated with a compensatory dilatation of the ventricles. To be of value in the diagnosis of a tumour the fluid must show not only increase in quantity, but also in pressure.

The Nature of the Fluid.—A case will be quoted later in which, while both lateral ventricles contained an increased quantity of fluid under increased pressure, the fluid in one ventricle was normal in character, while that in the other ventricle was yellow and had a marked increase in its protein and cellular content. This indicated an obstructive lesion in the region of the foramen of Munro.

Conclusions Which May be Drawn from the X Ray Films.

The conclusions which may be drawn from the X ray films may be stated under three headings:

1. Gross displacement of the whole ventricular system, the so-called mid-line shift.

2. Gross alteration in size and shape of the ventricles. The cross section of the body of the lateral ventricle is roughly triangular (Figure I); and in the earliest stage of dilatation the angles of the ventricular cross section will be found to be rounded off or clubbed, a condition comparable to the clubbing of the renal calyces in early hydronephrosis.

3. Gross asymmetry or deformity of one ventricle.

INFORMATION WHICH MAY REASONABLY BE EXPECTED FROM VENTRICULOGRAPHY.

In all cases in which it is difficult to localize the tumour, the point of first importance is to determine whether the tumour is situated above or below the tentorium. And it is on this very point that the few physical signs present are so often contradictory. It is a common-place that a tumour of the frontal lobe may mimic a cerebellar lesion, and *vice versa*; and ventriculography serves its greatest purpose in the differentiation between these two lesions. If, during the investigation of such a doubtful case, it is found that the lateral and third ventricles

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are grossly and symmetrically dilated, the tumour must lie in the region of the Sylvian aqueduct or below it. Obviously, a tumour in the vicinity of the aqueduct will give rise to many other signs; and in the absence of these signs it is conclusive evidence that we are dealing with a tumour in relation to the contents of the posterior fossa. If, on the other hand, the ventricles are found to be small, it is fairly conclusive that the tumour lies above the tentorium, and then some gross asymmetry or displacement of the lateral ventricles will indicate in which hemisphere the tumour is situated, and also in which region of that particular hemisphere.

ILLUSTRATIVE CASES.

The following brief case reports will serve to illustrate some of the points previously mentioned.

Cerebellar Tumours Which Did Not Give Localizing Signs, but in Which the Ventriculograms Were Typical.

CASE I.—A.W. (May, 1932), aged seventeen years, was admitted to hospital complaining of headaches, vomiting and a tendency to bump into people in the street on his right side over a period of ten weeks; bilateral papilloedema was the only reliable physical sign present. The ventriculogram revealed gross symmetrical dilatation of his lateral ventricles, the third ventricle not being outlined (Figure II). At operation a huge cyst was found in the right cerebellar lobe; a thorough search failed to reveal the presence of any mural nodule or tumour. There has been no recurrence of symptoms to date, and the patient has been fully employed as a market gardener for fifteen months.

FIGURE I.[1] Normal encephalogram— transverse section of body of lateral horns, showing their triangular appearance. Early dilatation is shown by "clubbing" of the upper and outer angles. Dotted lines indicate the anterior horns and the third ventricle.
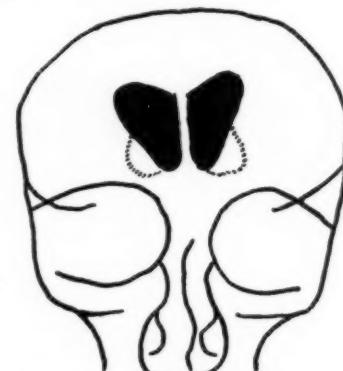
FIGURE II. Case I. Forehead uppermost. Gross symmetrical dilatation of lateral ventricles.

[1] The figures illustrating this article are tracings made from lantern slides of actual cases. The completely shaded portions indicate the shadow of the body of the lateral ventricles, the dotted lines indicate the shadow of the third ventricle when present or the anterior horns of the lateral ventricles.

CASE II.—M.S. (June, 1932), aged twenty-nine years, was admitted to hospital complaining of headache and vomiting for four months, and diminution of vision for one month, which had progressed to total blindness just before admission to the hospital. As she was seven months pregnant, her symptoms had been regarded as being due to the toxæmia of pregnancy. She was examined by a number of observers, and the only positive neurological sign was bilateral papillœdema. Again the ventriculogram (Figure III) was typical of a posterior fossa lesion, and at operation an angioblastic meningioma, the size of a large walnut, was removed from the right cerebellar lobe. She remains totally blind, but is able to do a certain amount of housework and to attend to her child.

Cerebellar Tumour with Indecisive Pyramidal Tract Signs.

CASE III.—Mrs. I.R. (January, 1934), aged thirty-seven years, was admitted to hospital complaining of severe right-sided headache and vomiting. Neurological examination revealed localized tenderness in the right parietal region, a dilated and sluggish left pupil, and weakness of the right arm and leg with exaggerated tendon reflexes, and loss of the right superficial abdominal reflexes. Bilateral papillœdema was present, the swelling being slightly more advanced in the right

FIGURE III.   Case II.   Lateral view, showing great enlargement of lateral ventricle.
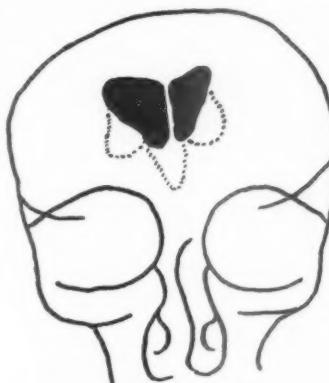

FIGURE IV. Case III. Forehead uppermost. Air distending grossly dilated body and anterior horns of lateral ventricles, and the anterior half of third ventricle.

eye. The ventriculogram (Figures IV and V) revealed marked symmetrical dilatation of the lateral ventricles, dilatation of the third ventricle, and a film taken with the occiput uppermost showed air in the dilated Sylvian aqueduct, all indicative of a subtentorial lesion. At operation an angioblastic meningioma again was found in the right cerebellar lobe and removed, apparently *in toto*. The patient was discharged ten days after operation in excellent condition.

Frontal Lobe Tumours with Signs Suggesting a Posterior Fossa Lesion.

CASE IV.—M.T. was admitted to hospital from Broken Hill with a history of some three months' duration, consisting of headache, vomiting, giddiness, diplopia and loss of power in the right hand and forearm. Neurological examination revealed a high degree of bilateral papillœdema, tenderness, rigidity and wasting of the right suboccipital group of muscles, total loss of function of the right fifth nerve, motor and sensory, with corneal ulceration in the right eye, and marked loss of power in the right hand and forearm. A tumour of the right cerebellar region was suspected. Ventricular puncture disclosed small ventricles, which therefore negatived the provisional diagnosis, and the ventriculogram (Figure VI) revealed a mid-line shift to the left, with displacement downwards of the body and anterior horn of the right ventricle. At operation

through a right transfrontal osteoplastic craniotomy the right frontal lobe was found to be replaced by a huge cyst containing yellow albuminous fluid, and in the postero-superior wall of the cyst a solid tumour was found and removed by the endothermy loop. The tumour proved to be an oligodendroglioma. The patient has been at work in the mines since November, 1933.

CASE V.—V.E. (December, 1933), aged sixteen years, was admitted to hospital with a history of headaches, vomiting and staggering gait for four months. He had had one fit, the description of which certainly suggested a Jacksonian attack, in the left arm and leg. This had occurred early in his illness, and at the time of examination no evidence of a cerebral lesion could be obtained. Both disks
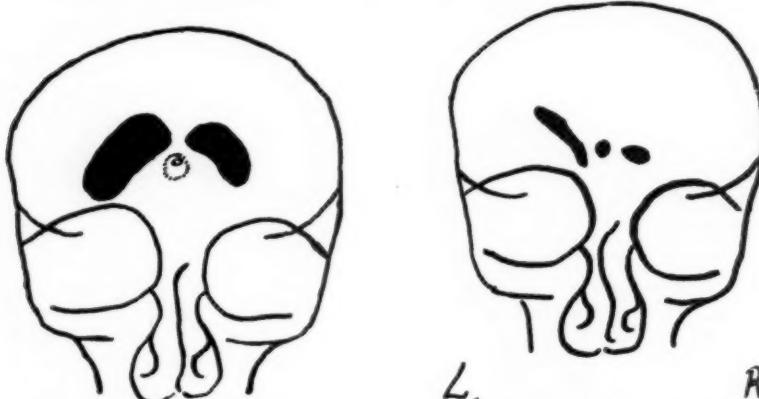
FIGURE V. Case III. Occiput upper-most. Air outlines distended posterior horns of lateral ventricles. Note also air in the posterior end of third ventricle. In the stereoscopic skia-grams air could be seen in an enlarged Sylvian aqueduct.

FIGURE VI. Case IV. Air shadows show mid-line shift to left and a little air in third ventricle. The body and anterior horn of the right ventricle are deformed and displaced down-wards by what was subsequently found to be a large cystic tumour of the right frontal lobe.

showed swelling to a degree of six diopters, and the staggering ataxic gait was pronounced. It was considered that, at his age and with the very marked choked disk, the most probable diagnosis was a subtentorial lesion; but it proved to be a condition exactly similar to that of Case IV. The left ventricle was slightly dilated, the right ventricle collapsed, and there was obvious shift of the mid-line to the left side, with no air showing in the anterior horn of the right ventricle (Figure VII). At operation a similar cystic oligodendroglioma was found in the right frontal lobe, but in this case the tumour mass was much larger, and the removal of the tumour by the endothermy loop laid open the anterior horn of the lateral ventricle. As in the preceding case, the operation has been followed up by X ray therapy, but the boy still complains of some headache, and a second craniotomy will probably be necessary.

Cerebral Atrophy with Dilated Ventricles.

CASE VI.—A.D. (June, 1933), aged fifty-four years, had suffered for some weeks from loss of memory, mental changes and loss of instincts of cleanliness; he had some slurring of his speech and right-sided hemiparesis. A left frontal tumour had been suspected, and he was referred to the surgical side for con-firmation. There was no papilloedema, and spinal manometry recorded a low cerebro-spinal fluid pressure. The ventriculogram (Figure VIII) revealed

symmetrical enlargement of the lateral and third ventricles, but there was no increase of pressure of the fluid within the ventricles. The subsequent history of the patient indicated a condition of cortical degeneration.

Frontal Lobe Tumour with no Localizing Sign Other than an Unaccustomed Degree of Bad Language.

CASE VII.—H.D. (October, 1933), aged forty-four years, was admitted to hospital with a history of severe frontal and occipital headache of four weeks' duration. His wife stated that his language had recently become unusually bad, but in the absence of other localizing signs the bad language was not regarded as sufficient reason to warrant exploration of the frontal lobes. Three diopters of swelling were present in each optic disk.
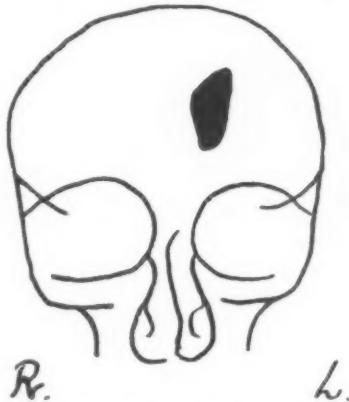
FIGURE VII. Case V. Air in the dilated left ventricle, no air in the collapsed right ventricle. No air in the third ventricle.
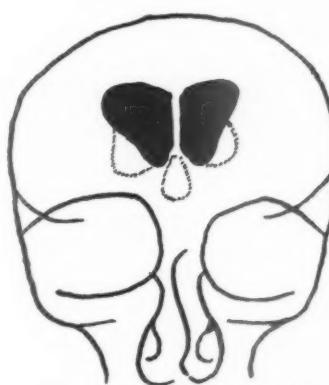
FIGURE VIII. Case VI. Dilatation of third and symmetrical dilatation of lateral ventricles. Forehead uppermost.

The subsequent procedure in this case is quoted at length, in order to indicate some of the complications and dangers of ventriculography, and to point out errors in technique. Although the pre-operative and operative technique was at fault, this case illustrated better than any other the value of ventriculography in the localization of an obscure lesion.

On October 25, 1933, at 2 p.m., the right ventricle was punctured; about 60 cubic centimetres of clear fluid under greatly increased pressure were run off and replaced by 40 cubic centimetres of air. The assumption was made (quite wrongly as it proved) that this large quantity of fluid indicated dilatation of both lateral ventricles, which supported the provisional diagnosis of a posterior fossa lesion. This provisional diagnosis had been made on the grounds that this is the commonest lesion to cause bilateral choked disk with absence of other signs. This faulty assumption would not have been made had one observed the rule that both lateral ventricles should always be punctured.

At 6 p.m. the films were examined (Figure IX), and it was realized that only the right ventricle had been emptied, and that there was no air in either the third or the left lateral ventricle. Instructions were given that a close watch should be kept upon the patient for signs of the onset of coma. If a tumour is present in one hemisphere, and is giving rise to signs of pressure,

reduction of pressure in the opposite hemisphere will obviously subject the patient to the risk of displacement of the mid-line structures to the side of the lower pressure, with herniation of the brain underneath the lower free border of the *falx cerebri*; this is clinically associated with the onset of coma.

On October 26, 1933, at 5 a.m., the patient had developed signs of the onset of coma; the left ventricle was punctured, and about 40 cubic centimetres of yellow, highly albuminous fluid were run off. By 8 a.m. he had recovered consciousness. The discovery of this abnormal fluid in the left ventricle, together with the fact that the original tapping had not been able to empty the left ventricle, made it almost certain that the tumour was situated in a position which resulted in obstruction of the left foramen of Munro.

During the next week some of the sequelæ of ventricular puncture were manifest, visibly, pyrexia, stiff neck and suboccipital tenderness and vomiting. These signs all disappeared within a few days, as they generally do.

On November 7, 1933, both ventricles were again tapped; only ten cubic centimetres of yellow albuminous fluid could be extracted from the left ventricle,

FIGURE IX.   Case VII.   Forehead uppermost.   Aid only in dilated right ventricle, which is displaced to the right.
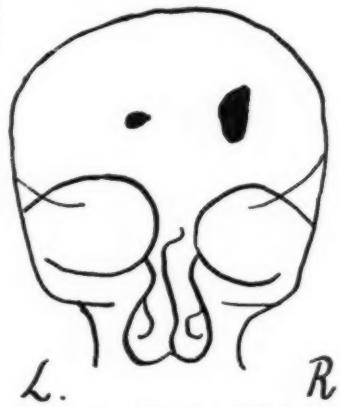
FIGURE X.   Case VII.   Second ventriculogram.   Forehead uppermost. Note shift of right ventricle to the right; also note the wide separation of the shadows of the anterior horns. It was not possible to admit enough air to outline the bodies of the lateral ventricles.

and they were replaced by air. At the same time, 20 cubic centimetres of clear fluid from the right ventricle were replaced by air. The films (Figure X) showed that there was still no air in the third ventricle, and that the anterior horn of the left ventricle was almost occluded, and that the shadows of the anterior horns of the lateral ventricles were separated by more than 3·75 centimetres (one and a half inches). The conclusion drawn was that a tumour was present in the medial wall of the anterior horn of the left ventricle, which was occluding the left foramen of Munro.

On November 11, 1933, at operation the frontal lobe was incised down to the anterior horn of the ventricle, and a tumour (*glioblastoma multiforme*) was found as suspected on the inner wall of the anterior horn of the ventricle. An almost total removal of the tumour was performed, but the patient succumbed on the following day from acute cerebral œdema.

It would have been much wiser to have performed the operation in two stages, though the highly malignant nature of the tumour would ultimately have led to the same result.

ACTINOMYCOSIS OF THE FALLOPIAN TUBES, WITH REPORT OF A CASE.

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INCLUDING A STUDY OF THE CELL REACTIONS AND TISSUE REACTIONS.

By D. A. WELSH,
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FOREWORD.

THE study of actinomycosis in humans and of the facts related thereto has been of special interest to me ever since my arrival in this district almost twenty years ago. When I arrived here I held the commonly accepted belief that actinomycosis was a *rara avis* in Australia. I was therefore naturally much interested in a case which came under observation during my first week in Newcastle. The patient was a male, aged forty-three years, who after being operated upon for subacute appendicitis, which was followed by discharging actinomycotic fistulæ necessitating several further operations, subsequently died from actinomycotic pyæmia.

Ever since then I have been "actinomycosis conscious", and during the course of the study of the disease have observed forty-six cases in public hospital and private practice. In twenty-six of these cases the infection has been located in the cervico-facial region, and in at least one case the infection was due to a strictly aerobic organism. Nine cases involved the cutaneous and subcutaneous tissues. In four the infection was chiefly or entirely confined to the thoracic region; one of the four was apparently a case of primary catarrhal pulmonary actinomycosis. In four cases the infection was mainly confined to abdominal organs other than the genital organs. In two cases the urinary system was involved; one of these appears to be a case of bilateral "excretory" actinomycosis; the other, an example of ascending infection of the right kidney from a primary focus in the urethra. In one case the infection appeared to be an "isolated" infection of both Fallopian tubes. The youngest patient was aged two years, the oldest seventy-seven. Twenty-nine were males, seventeen females. Nineteen of the patients lived in rural districts.

A careful study of these cases has led me to conclusions which are in conflict with certain generally accepted opinions regarding the disease, namely, (i) that the disease is always a suppurative process; (ii) that actinomycosis is due to one distinct microorganism; (iii) that infection does not spread by lymphatic vessels.

I have approached the subject with an entirely open mind, and the reasons which have compelled me to arrive at these conclusions are outlined in this and subsequent articles.

These views are not advanced in any polemical spirit, but are the honest opinions of one who is encouraged by the hope that they will arouse a greater interest in the study of this disease. If they achieve this, I shall be amply rewarded.

As much of the literature on this subject is not procurable in Australia, I have prepared an appendix containing a *précis* of reported cases. In order to help those who are interested, I have forwarded to the library of the Royal Australasian College of Surgeons translations of all available case reports.

I wish to express my great indebtedness to Professor D. A. Welsh, Department of Pathology, University of Sydney, for the cytological and histological reports of sections of specimens obtained at operation and at autopsy examinations; to Dr. Franklin H. Martin, Director-General of the American College of Surgeons, for most of the literature; to Professor Woodruff, Department of Bacteriology, University of Melbourne, for examination of cultures and smears obtained from cases reported from the Mater Misericordiæ Hospital at Waratah; also to Mr. E. Ethell, Laboratory Technician, late of the Department of Bacteriology, University of Melbourne, for microphotographs and technical assistance with cases reported from the Mater Misericordiæ Hospital, and also private cases; to the honorary and resident staff of the Bacteriology and X Ray Departments of the Newcastle Hospital for bacteriological and X ray examinations of cases reported from Newcastle Hospital; to the Council of Physicians at Praha, through the courtesy of the Consul for Czechoslovakia, Sydney, for Czechoslovakian literature; to Dr. Nel, Amsterdam, through the courtesy of the Acting British Consul at Amsterdam, for Fehmer's articles; to the Consul for Austria, Sydney, for Fatyol's articles; to Dr. Ahlstrom (Stockholm), Dr. Heidler (Vienna), Dr. Jacobson (Los Angeles), Dr. Keynes (London), Dr. Snoke (Philadelphia), for personal communications; to Dr. J. H. L. Cumpston, Director-General of Health, Canberra, for a synopsis of Australian literature; and to Professor H. R. Dew, of the Editorial Committee of this journal, for valuable advice as to the arrangement of the material contained in these articles.

HISTORICAL REVIEW.

In 1845 Langenbeck[1] observed and prepared drawings of peculiar yellow bodies found in pus from a case of vertebral caries in a young

man. The drawings were published together with a reference to the case by Israel in 1878.

The first published observations were made by Lebert in 1848. Lebert[1] received from Louis some curious gelatinous pus from an abscess of the thoracic wall of a man who was suspected to be suffering from pulmonary cancer. Lebert described little slightly greenish-yellow spherical bodies, each about the size of the head of a pin, which he had obtained from this pus.

Robin[1] later described and accurately figured yellowish grains, recognized later as actinomyces granules, found in the pus of two or three cases of chronic deep-seated abscesses in man.

In 1876 Bollinger[2] demonstrated that the clinical picture of scrofulous disease, osteosarcoma *et cetera* in the jaws of cattle, described by previous veterinarians, was especially characterized by the presence of yellowish granular bodies in the lesions. Bollinger gave some of these granular bodies to Harz,[2] a botanist, who suggested the name *Actinomycis boris*, or, literally, the ray fungus, on account of the radiate arrangement of the separate elements in the conglomerate growths found in the diseased tissues.

In 1878 Israel[1] published his observations of two cases, which he definitely described as cases of pulmonary actinomycosis.

Ponfick[1] in 1879 was the first to recognize clearly that this disease was identical in man and cattle.

Israel also published an interesting collection of illustrations of the organism in 1884.[3] Israel's[4] monograph published in 1885 contains the clinical records of thirty-eight cases of human actinomycosis, some of them his own and some those of other authors reported in the literature.

Bostroem presented cultures of actinomyces at a medical congress in 1885,[5] and in 1890[6] reported the isolation of an aerobic organism in pure culture from seven out of eleven cases of maxillary actinomycosis in cattle and from a case of pulmonary actinomycosis described in his series of twelve human cases and also from human material obtained from Ziegler. He also contradicted his earlier report of successful transmission of the disease to rabbits.

The transactions of the International Congress at Berlin in 1890 show that Wolff and Israel[7] were the first to succeed in cultivating in pure culture the now generally accepted type of organism met with in human cases, and in producing the disease in animals by inoculation with cultures, the organism being cultivated from a male suffering from closed actinomycosis of the retromaxillary region. The results of experiments on eleven rabbits were reported, and, as in actinomycosis in man, it was noted that the inoculated animals often showed actinomyces colonies without clubs.

In 1891[8] they reported the results of intraperitoneal experiments on twenty-two animals—three guinea-pigs, eighteen rabbits and one sheep. Eighteen animals were killed after a period of four to seven

weeks and in the case of all the animals except the sheep inoculation tumours were found in the peritoneal cavity; all of the tumours showed typical actinomyces colonies. The tumour formations were local and confined to the peritoneal cavity.

Later Wolff[9] admitted that, though there could be no doubt of dissemination, the area of extension was nevertheless a limited one. At first they did not succeed in reproducing a generalized actinomycosis as in man, or at least they did not succeed in procuring a migration of the organism into the parenchymatous organs of the abdomen. Finally he found, within the liver of one of the experimental animals, a metastatic formation similar to the metastatic actinomycosis frequently found in man after infection from the intestinal tract. In addition to tumours in the abdominal cavity, the animal showed in the liver two which were completely surrounded by hepatic tissue and which showed a content of soft consistency. The granules about the size of millet seeds and the colour of sulphur were definitely similar to those found in man.

Since the publication of the observations by Bostroem, Wolff and Israel, some animal experiments have been recorded, a number of reports on a causal organism have been made, and many cases of actinomycosis have been described in the literature of the various countries of the world.

In England the first case, that of Harley[10] in 1885, was recognized after death in sections of the liver by Sharkey and Acland.[11] The use of Gram's method, which showed clearly the mycelial network and clubs of the organism, was first employed by Acland[11] and had not been used by German observers.

Shattock[12] examined specimens of liver in Saint Thomas's Hospital museum during the same year, and detected the organism in two cases.

Powell's[13] case in 1888 was the first diagnosed during the life of the patient.

In Scotland the first case, that of Stewart and Muir[14] in 1893, and the second case, that of Leith[15] in 1894, were diagnosed after death.

The first case diagnosed during the life of the patient was described by Knox.[16]

In Ireland, Littledale[17] in 1900 verified Bennett's clinical diagnosis of actinomycosis *post mortem*; the following year the diagnosis was made during the life of a patient by Earl.[18]

If Lebert's[1] case be excepted, the first case in France was noted in a living human subject by Nocard[19] in 1887, the same year in which the first case was reported in Norway.[20]

In Egypt, Milton[21] recognized the first case during life in 1893.

In the United States of America the human form of the disease was first recognized by Murphy[22] in 1885, in Canada by Bell[23] in 1900, in India by Sur[24] in 1915.

In Australia, McInerney[25] in Victoria diagnosed the first case in man in 1889, and Park[26] in the same year or a little earlier ascertained that cases of human actinomycosis were frequently met with in Queensland, especially on cattle runs where the animals were similarly affected.

ACTINOMYCOSIS OF THE FEMALE GENITAL ORGANS.

In available literature seventy-six cases of actinomycosis of the female genital organs have been recorded. The ovaries were infected in fifty cases, in twenty-one of which the right ovary was infected; in twelve the left; bilateral infection was present in ten cases; and in the seven remaining cases it is not stated which ovary was infected.

In rare cases the ovarian tumour is described as lying entirely free and immersed in pus, though in most cases as adhering firmly to other structures in the pelvis, varying in size from that of a walnut to that of a goose egg, and in colour from the uniform greyish-white of normal ovarian tissue to a "strangely mottled appearance".

The consistency of the ovarian mass is described as soft and friable, fluctuating, elastic, and in one case very hard. The smooth or roughened and sometimes moth-eaten surface of the rounded or irregularly ovoid ovarian mass in some cases showed protrusions varying in size, number and appearance. In one case the lesion was confined to a small area, but frequently little or no normal ovarian tissue was found. In some cases pus exuded at a few or many points from the surface of the mass even without application of pressure. The presence of a foreign body is mentioned in one case only.

On cross-section, few or numerous, large or small, regular or irregular cavities filled with pus of varying colour were observed in a fine to a coarsely meshed network of milk-white to greyish-black connective tissue, giving to the cut surface a cheesy, spongy, moth-eaten or honeycomb appearance. Pus, when present, was usually thick and slimy, and varied in colour and quantity. Granules of varying colour and shade, and often so small as to almost escape detection with the naked eye, were sometimes found in the pus, some apparently young and sago-like in appearance, others old, hard and similar to grains of sand. The cytological and histological picture varied, and it was only the presence of one or more actinomyces colonies in the pus or in sections of the mass which enabled one definitely to diagnose actinomycosis.

In nine cases of ovarian actinomycosis definite tubal infection was also present. In some cases in which the ovary was definitely infected no trace of tubal structure was found during operation or at autopsy, or even on microscopic examination of sections of the conglomerate tumour originally consisting of tube and ovary. In other cases in which there was definite evidence of infection in the ovary, although inflammatory or suppurative changes were observed in the tube, actinomyces colonies could not be found in the wall or lumen of the tube.

The brief report of one case of actinomycotic salpingitis does not definitely state whether other pelvic organs were completely free from infection. In other reported cases the infected tubes were more or less thickened, twisted and distorted in form, or transformed into pus sacs of various sizes and which contained actinomyces colonies. One case of apparently isolated acute tubal infection has been recorded in which bilateral tubal abscesses were found at operation. Although actinomyces colonies were found in the pus in the lumen of both tubes, microscopic examination did not reveal the presence of actinomyces colonies in sections of the walls of the tubes.

In the case of actinomycotic salpingitis reported in this article, although definite inflammatory changes were observed on microscopic examination of both Fallopian tubes, there was no definite evidence of suppurative changes or the formation of pus in the wall or lumen of either tube.

Compared with the number of cases in which the adnexa were involved, infection of the uterus is rare, there being only seven cases reported in available literature. In one case the uterus was prolapsed and the infection was limited exclusively to the cervix. In the remaining six cases one or both adnexa were also infected. The anterior wall of the uterus in one of these cases and the whole of the muscular wall of the body of the uterus in a second case contained numerous abscesses filled with pus and granules. In a third case an irregular cavity filled with yellow purulent material was located in the cervix. In a fourth case the body of the uterus was transformed into a spongy, cheese-like mass and the cervix was not involved. In a fifth case in which both tubes and ovaries contained actinomyces granules, the uterus was only five centimetres long and consisted mainly of cervix. The mucosa of the uterus was smooth and pigmented. The cavity of the uterus was somewhat distended and contained a few actinomyces granules. In a sixth case the patient had recently been delivered of her twelfth child. Numerous small abscesses were found in an irregular nodular pale area in the posterior surface of the enlarged uterus.

Actinomycosis of the parametrium and pelvic connective tissue has been often found associated with actinomycotic lesions in the uterus and adnexa. In a few cases the infection is much less in evidence in the parametrium or pelvic connective tissue than in the uterus or adnexa. The progressive local extension of the infection to neighbouring organs and surrounding tissue may be accompanied or subsequently followed by hæmatogenous dissemination of the infection.

Short or long, irregular, external and/or internal fistulæ, resulting from surgical interference or from the spontaneous rupture of one or more superficial, or deep abscesses associated with a limited focus or extensive area of infection in the pelvis, may discharge continuously or intermittently small or large amounts of thin, serous, or thick, purulent and sometimes granular material.

"Primary" and isolated actinomycosis of the external genitals has been recorded in three cases, and in a few cases secondary lesions have been observed in the external genitals as a result of extension of pelvic infection.

Pregnancy appears to exert an unfavourable effect on actinomycotic infection, irrespective of its genital or extragenital location.

One patient who was suffering from actinomycosis of the internal genital organs had been treated previously for gonorrhœa, and another was a congenital syphilitic.

Very few cases have shown promise of permanent recovery.

Origin of Infection and Mode of Invasion.

A number of authors have pointed out that the origin of infection in the female genital organs cannot always be determined with certainty.

The weight of authority favours the contention that the intestinal tract, including the rectum, is really the only possible source of infection of the female internal genital organs.

A study of the literature on actinomycotic lesions of the female internal genital organs to which intestine is adherent, shows that the ovaries, particularly the right ovary, are frequently the chief location of the infection. This frequency is possibly due to the proximity of the appendix, the commonest site of abdominal actinomycotic infection, and also to the anatomical structure of the ovary itself, in that it is deprived of the protective effect of a peritoneal covering and also to the possible production of a favourable soil for colonization of the organism on the surface of the ovary in the physiological wound produced by ovulation.

The failure to demonstrate the presence of a macroscopic or microscopic lesion in the intestine adjacent or adherent to the infected portion of the internal genital organs has been variously explained. Some writers maintain that some small lesion necessary for the passage of the organism of actinomycosis through the mucous membrane of the intestine, heals and leaves no trace of infection; others state that the organism can pass through the mucosa without producing a lesion. Some authors have observed that in apparently primary intestinal actinomycosis the secondarily affected organs—peritoneum, ovaries, liver—show far greater destruction of tissue than that found at the site of apparent primary origin. Other organisms may help to cause this extensive spread of infection and destruction of tissue.

From an apparently primary focus in the intestinal tract the internal genital organs may become infected intraperitoneally or extraperitoneally.

As a result of intraperitoneal dissemination from the intestinal tract, fibrous indurated adhesions, actinomycomata and abscesses may be formed between loops of intestine, internal genital organs, bladder and abdominal wall, and eventually may lead to the formation of sinuses and fistulæ—intestinal, urinary or vaginal. When the internal genital

organs are infected by dissemination along the retroperitoneal tissues, abscess formation, destruction of muscle and bone and thrombosis of the pelvic veins may occur and eventually perforation of the skin in the inguinal, gluteal, thigh or anal regions or the fornices or wall of the vagina.   In many cases in which intestine is adherent to the internal genital organs it is difficult to determine to what extent the internal genital organs have been infected from the intestinal tract or, conversely, to what extent infection of the internal genital organs has contributed to infection of the intestinal tract.

Robinson[27] has suggested that his patient became infected by the blood stream as well as from the intestinal tract, because the actinomycotic colonies were located not only within the lumen of the tube, but also deep in the ovarian stroma and not upon or immediately beneath the germinal epithelium.   Although intestinal adhesions were found at operation or at autopsy, a few authors who report isolated actinomycotic lesions in the ovary, have suggested hæmatogenous invasion as the mode of origin of the infection, the leucocytes, in which portions of mycelial filaments have frequently been observed, acting as vehicles for transporting the infection from a distant unrecognized primary focus.   In cases such as these authors have described, if the organism of actinomycosis cultivated from the blood stream was proved to be identical with the organism cultivated from the ovarian focus of infection, it may admittedly appear conclusively proved that infection was carried by the blood stream; but it must be remembered that one cannot exclude with certainty the possibility of infection from the intestinal tract or cervix, even though evidence of infection at the site of origin—intestinal tract or cervix—may have completely disappeared at the time the infection in the ovary is under treatment.

In available literature only two cases, both occurring in males, have been reported in which the organism has been isolated from the blood stream, thus conclusively proving dissemination of the infection by the blood stream.

Shrewsbury[28] isolated the organism from dermal abscesses and from the blood of a living patient suffering from pyæmia.

Fellinger and Salzer[29] isolated the organism from the pus of abscesses and from the blood and splenic pulp of a cadaver.

Although Harbitz and Grondahl[20] have stated that the infection does not spread by the lymphatics, except near the very end of the disease, many authors deny the possibility of infection spreading by the lymphatics at any period of the disease.

Grill,[30] among others, maintains that the small vascular lumina of the commencement of the lymphatic system are too small to admit the entrance of the organism of actinomycosis.

Aribaud[31] agrees with Israel, who believes that in the pyæmic form of the disease the organism passed first into the lymphatic vessels and then into the blood stream.   Aribaud states that most observers who have denied extension by way of the lymphatics have reached this

conclusion a priori on account of the usual absence of adenitis in the neighbourhood of the actinomycotic foci.

Keynes[32] refers to lymphogenous spread of infection in a patient on whom an unsuccessful attempt had been made to remove an actinomycotic granuloma in the infraorbital region and who developed metastatic infection in one of the glands of the neck.

Bevan[33] found actinomycotic infection in the inguinal glands of a patient suffering from rectal actinomycosis.

Sur[34] found typical actinomycotic arrangement of filaments on microscopic examination of sections of cervical glands obtained from a patient in whom no sign of any primary focus of infection could be detected.

Bates[35] has reported two cases of actinomycotic infection in the sternomastoid region; one case showed infection of muscle and a lymphatic gland, the other infection of a lymphatic gland alone.

Schwarz[36] has recently reviewed available literature on actinomycotic infection of lymphatic glands. He reports the case of a boy, aged nine years, who had been ill for four months and had developed a hard painless swelling above his left clavicle which had been provisionally diagnosed as tuberculosis of the glands. Microscopic examination of sections of the glandular mass removed at operation revealed the actinomycotic nature of the infection. No primary focus was discovered.

Although most authors deny the possibility of infection from the vagina or cervix, the history, clinical signs, operative findings and autopsy disclosures sometimes make this route appear to be the probable source of infection.

The majority of surgeons believe that in any acute fulminating infection of the cervix, particularly immediately after menstruation or in the puerperium, the causal organism may travel along the endometrium and infect the tubes. It is generally believed, too, that in many infections of the cervix, infection is limited to the mucous glands and the immediate surrounding tissue of the cervix. In some cases the infection spreads by an ascending lymphangitis and may infect a portion or even all of the internal genital organs as there are no glands to impede the progress of the infection.

It would therefore seem possible that, in some stage of its life history, the organism of actinomycosis may enter the cervix and infect a portion or even all of the internal genital organs by direct spread along the endometrium in acute infections or by lymphogenous spread in subacute and chronic infections, and thus explain in a direct way actinomycotic infections of at least portions of the internal genital organs which are not adjacent or adherent to definitely infected intestine, the organism either having directly entered the cervix, leaving no trace of infection, or the macroscopic and microscopic evidence of a primary lesion in the cervix having entirely disappeared at the time the infection

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of the body of the uterus, tubes, ovaries or parametrium is under treatment.

In fact, in the case of cervical actinomycosis reported by Giordano[37] —the only generally accepted case of primary actinomycotic infection of the cervix—the point of entry and the primary area of infection, that is, the site at which the organism first induced pathological changes in the tissues, coincide.   Moreover, in a few cases of actinomycotic infection of the genital organs, evidence justifies the assumption that the organism invaded the affected part from the vagina or cervix following the induction of criminal abortion or the introduction or reintroduction of contraceptive apparatus.

Clinical Features.

A review of the literature clearly shows that the symptoms and course of actinomycotic infection of the internal genital organs are not characteristic, but are similar to those produced by almost any other infection.

The disease may pursue an acute, subacute or chronic course.

In acute infections a previously apparently healthy female is suddenly seized with acute localized or diffuse lower abdominal pain, vomiting and fever resembling the symptoms produced by an acute attack of inflammation of the appendix, adnexa or pelvic peritoneum.

In subacute infections symptoms referable to the genital organs may be absent altogether. A history of previous acute infection which abated with or without treatment is often obtained, sometimes disturbances of menstruation have been noticed over a short period, and frequently an operation for appendicitis or tumour—inflammatory or neoplastic—of the adnexa has been performed. Pain varies in severity, character and location, and may be slight or moderately severe, continuous or intermittent, localized to one or both sides of the lower part of the abdomen or referred to the lumbar, sacral, or gluteal regions or to one or both lower limbs, depending on the localization and direction of extension of the infection, and may be aggravated by defæcation, micturition or exertion. Fever may be absent, intermittent or continuous and may be accompanied by rigors and sweats. The attention of the patient is sometimes attracted by the insidious onset and development of a pelvic or abdominal tumour, which may appear to improve with medical treatment.

In chronic infections there is often a history of previous subacute or even acute attacks at irregular intervals, sometimes disturbances of menstruation have been noticed for a long period, and frequently one or more operations have been performed.   There is generally a prolonged history of pain and general ill health, with gradually increasing weakness, anorexia, loss of weight and pallor, which sometimes is found to date from a previous confinement or abortion. Abdominal pain and fever vary in severity and degree, and may necessitate confinement to bed. If a pelvic or abdominal tumour has

been previously noticed, extension to the abdominal wall is frequently observed, and sometimes indurated tumours may appear in the inguinal, umbilical or gluteal region. These become adherent to the skin, cause discoloration and subsequent abscess formation which may spontaneously rupture and discharge pus or necessitate operation. In cases in which infection invades the walls of the bladder and rectum, frequent painful micturition, tenesmus and diarrhœa increase the cachexia and death soon ensues, particularly when there is superadded upper abdominal and thoracic infection.

Diagnosis.

In acute and subacute infections of the female genital organs it is frequently impossible by abdominal, vaginal and rectal examination, even when aided by general anæsthesia, to differentiate clinically between lesions caused by the organism of actinomycosis and those produced by almost any other organism. One must ever be "actinomycosis conscious", remembering always the possibility of the occurrence of actinomycotic infection in all inflammatory and neoplastic disorders of the female genital organs, particularly cases which do not react favourably to conservative or surgical treatment.

Leucocyte counts and sedimentation tests show little or no indication of the severity of the infection, unless the infection is very acute or superadded secondary infection is present. Serological tests— agglutination, complement fixation *et cetera*—and also dermal reactions with culture filtrate have rendered little or no service in the diagnosis of actinomycotic infection of the female genital organs.

In actinomycotic infections of the head and neck, a region clinically regarded by many as the only region liable to be infected by this organism, a diagnosis is generally made and is followed by operation, but in infections of the female genital organs operation is generally performed in order to make a diagnosis.

When an operation is performed on the female genital organs it is essential to have an immediate systematic bacteriological examination made of the maximum amount of purulent material that can be evacuated, and also later a careful histological examination of a number of sections of various portions of any inflammatory or neoplastic mass removed at operation, as the macroscopic appearance of an actinomycotic lesion in this region is notoriously deceptive. An attempt should also be made to obtain cultures of the organism under favourable conditions in media suitable for aerobic, microaerophilic and anaerobic growth.

Haselhorst[38] emphasizes that in his case some of the infected areas showed numerous colonies and mycelial filaments on microscopic examination, and in other areas, with the same macroscopic appearance, but evidently older areas in which the infection had died out, the microscopic examination showed absence of colonies and mycelial filaments. He does not regard the variation in the appearance of these areas, which were in close proximity to one another, as being due to the effect of

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the small doses of X rays used in treatment, as has been suggested in a few published cases. He draws attention to the necessity for examination of numerous sections, particularly in the presence of secondary infection, and reminds us that necrotic foci in inflammatory non-actinomycotic tissue may produce histological pictures similar to actinomycosis, but not the typical colonies which furnish the only absolutely certain proof of the presence of the organism of actinomycosis.

The necessity of the presence of colonies as the absolute proof of actinomycotic infection has also been emphasized by Müller, who draws attention to the similarity of the histological picture produced by tuberculosis and actinomycosis.

That routine examination of specimens removed at operation is absolutely necessary is shown in the case reports of Champlin,[39] Brandenstein,[40] Black,[41] Griffith,[42] Chenhall[43] and others, in whose cases actinomyces granules were found in abscesses or fistulæ which developed soon after an operation on the female genital organs.

In chronic actinomycotic infections it is often difficult to make a diagnosis, even when abscesses and fistulæ which show little or no tendency to spontaneous recovery are present, as they may occur in other infections of the intestinal tract, particularly acute infections of the appendix, in other infections of the internal genitals, in inflammatory affections and neoplastic growths involving adjacent bony structures and in some cases in which foreign bodies are present in the pelvis. In the two last mentioned conditions, X ray examination is essentially helpful.

Clinical diagnosis is easy when granules are present in the pus of abscesses which have been incised or which have spontaneously ruptured, or when granules are seen in the thin watery or abundant purulent discharge of fistulæ, or when granules are seen in the urine, fæces or vaginal discharge. A common textbook description of actinomycotic pus is that it contains "easily recognized sulphur yellow granules". Often the granules are not sulphur yellow and are frequently not easily recognizable.

Brickner[44] states that:

The appearance of sulphur bodies is quite vagarious. The disease may be well advanced and suppurating for many months before persistent search for the organism is rewarded; after drainage (and secondary infection) they may disappear from the pus; or the granules may be found only at long intervals, or they may escape continued observation in the pus and yet be found in the tissues. The granule is a diagnostic fetish. Its absence from the pus has often led to failure to recognize the disease during life.

It must be remembered, too, that the presence of granules in pus does not necessarily mean that the infection is caused by the organism of actinomycosis; "pearls" of degenerated malignant tissue, small hard concretions and small seeds in intestinal fistulæ, small round masses of fibrin, tuberculous débris, crystals of iodoform et cetera, have been mistaken for actinomycotic granules, until a microscopic examination has been made.

Prognosis.

The rarity of recovery from actinomycotic infections compared with the results of treatment of most other infections of the internal genital organs in patients who present themselves for treatment in the early stages, when the disease is frequently localized and accessible, is due largely to the fact that the surgeon has not been "actinomycosis conscious" and consequently has omitted to have a careful routine systematic examination made of all specimens removed at operation.

When a patient presents herself for treatment late in the disease or when the true nature of the disease has been overlooked at a second or third operation, the prognosis is bad and sometimes hopeless on account of the extensive spread of the infection to inaccessible tissues and vital organs.

The prognosis is hopeless when the lesion is a hæmatogenous metastasis from a recognized or unrecognized distant primary focus of infection, which may remain the source of other new metastases.

Surgical Treatment.

The most important factor in obtaining a good result in the treatment of actinomycotic infection of the female genital organs, as in infection in any other part of the body, is early diagnosis. Spontaneous recovery, which is believed to have occurred in a few cases of actinomycotic infections in the abdomen, has not been recorded in definitely proved infection of the internal genital organs, nor is there any record of surgical treatment *per se* having cured this disease when located in this region.

The testimony of experience is in favour of surgical measures combined with medical treatment, particularly the oral administration of iodide of potash and X ray irradiation of the affected area.

Radical excision of the affected part or parts of the genital organs is advisable when the lesion is limited and accessible. If the lesion is widespread or inaccessible, in order to expose the affected part to the effects of oxygen, wide opening and drainage of areas containing abscesses, sinuses and fistulæ, with or without curettage, and local applications, are advisable. As recurrence is frequent, repeated operation may be necessary, particularly when abscesses develop, although a few authors have maintained that repeated operations are inadvisable on account of the liability of inducing secondary metastatic emboli.

Medical Treatment.

Although potassium iodide has been administered in watery solution or in milk, with or without surgical interference, since first introduced for the treatment of the disease in man by Nocard in 1892 and by von Iterson about the same time, and has been regarded as exercising a specific influence on actinomycotic lesions by many authors, particularly early authors, there is little or no evidence of definite cure in cases

of proved infection of the female genitals by an organism of the Wolff-Israel type—the usual organism found in actinomycotic lesions in man—when this drug alone is used or even when combined with surgical treatment, although some authors report improvement in the lesions.

Bérard[45] observed that the presence of 5% of potassium iodide in culture media had no lethal or even inhibitive effect upon the growth of the organism; but according to Rajewsky[46] the addition of 0·5% of potassium iodide completely checks development of the organism.

Most authors advise gradually increasing doses even up to 6·0 grammes (100 grains) three times a day, and stress the need to watch for symptoms of iodism, and also to continue the treatment for some time after symptoms and signs of the disease have disappeared.

Wilde[47] considers that the diuretic effect of large doses of potassium salts is an important factor in the prevention of iodism; most of the severe cases of iodism met with are produced by doses too small to act as diuretics.

According to Lieblein,[48] the presence of any mixed infection retards and even wholly prevents the beneficent action of potassium iodide.

Waterman and others have used sodium iodide intravenously in patients who were intolerant to iodides by mouth. Waterman[49] found that a small amount (0·3 gramme or five grains) caused a severe reaction, but that larger doses produced no reaction. Smith,[50] in his treatment of abdominal actinomycosis, recommends 30 to 40 cubic centimetres of a 10% sodium iodide solution for the first intravenous injection, and increases the dose by 10 cubic centimetres each day until 100 cubic centimetres are given.

Iodopin and other preparations containing iodine have been recommended for patients who are unable to tolerate iodides by mouth.

According to Knabe,[51] Pfeiler and Oberlander in 1921 inaugurated the use of "Yatren" in cases of actinomycosis. The same author has also called attention to two cases reported by Zeiler and Birmham in which a fatal acute yellow atrophy of the liver followed "Yatren" therapy. Barth[52] used "Yatren" and X ray irradiation in his case before infection with the organism of actinomycosis had been established.

"Yatren" has been used in combination with other treatment in actinomycotic lesions of the female genital organs by Martius, Heim and Bloch. Martius[53] used X ray therapy, potassium iodide and six intravenous injections of "Yatren" in the treatment of his patient, but attributes the apparent recovery as being mainly due to irradiation treatment. Heim[54] remarks that treatment with "Yatren" tends more to the mobilization of the defensive powers of the body than to the destruction of the organism. Bloch,[55] in view of the two fatal cases which had occurred, carefully tested and recorded the blood sugar and urinary findings during three series of treatment with "Yatren". A total of 1,153 cubic centimetres of 5% "Yatren" was given intravenously. His experience was similar to that of Zeiler and Birmham, in that he

determined that "Yatren" may induce functional disturbance of the liver. When this occurred, treatment was immediately suspended and was not resumed until the urine and blood sugar tests showed satisfactory results.

Radium Therapy.

In available literature there are recorded only two cases of patients suffering from actinomycosis of the female genital organs who received treatment with radium in combination with medical and surgical treatment. These two cases were reported by Brickner and Ikeda, and each patient had three radium exposures, but no details of the treatment are given. Brickner's patient received in addition three doses of X ray therapy.

X Ray Therapy.

After a study of the work of other men and from his own experiments, Kleesattel[56] concluded that X ray doses of ten skin erythema doses and less do not kill actinomyces in pure cultures; the descendants of cultures subjected to intensive irradiation and observed for a number of generations showed that their capacity for vegetation had not been diminished in the least. In one of the experiments, however, he observed that the X rays had an effect upon the life processes of the organism, that is, about a week after exposure to the rays there was a period of three or four days in which there was less vigorous growth. He concluded that the effect of X rays upon actinomyces in pure culture consists, at the very most, of slight, temporary interference with growth of the culture which is of no practical importance.

A comparison of the results in therapy with those obtained in experiment show that the two are not in proportion to each other at all. It would seem, therefore, that factors other than the direct effect of the rays upon the organism are responsible for the good clinical results; probably one of the most important factors is the reaction of the tissues to irradiation.

In 1903, X ray treatment was administered to a patient suffering from "malignant disease of the jaw", which Heidingsfeld[57] subsequently proved to be actinomycosis. In the same year, Harsha[58] used X rays in the treatment of definitely diagnosed actinomycosis of the jaw.

Bevan,[33] the following year, used X rays not only for lesions affecting the head, neck and thorax, but also for abdominal lesions. Bevan and his assistants performed experiments which showed that the X ray liberated free iodine in solutions of iodide of potash, and concluded that in a patient suffering from an actinomycotic lesion, who was saturated with potassium iodide and whose lesion was exposed to X rays, free nascent iodine was liberated in greater amounts at and about the seat of the lesion than without such exposure. Bevan regarded this "radio-chemic" treatment as an explanation for the apparent striking clinical results of such combined treatment.

In one of his abdominal cases, a young woman, aged nineteen years, before consulting the author, discharged *per vaginam* about a pint of grey pus, with a peculiar odour of decaying matter. On rectal examination a mass was found occupying the pouch of Douglas. The mass was incised and drained *per vaginam*. The peculiar bloody pus which escaped contained actinomyces granules.

Zwerg[59] draws attention to the observation of Stepp and Zermak, who point out that pathological tissues have a capacity for storing up iodine, and that this increases the destructive action of the X rays on the affected part. This suggests the possibility that the molecules of iodine with high atom content send out soft secondary rays which lead to intensification of the primary X rays. Acting on the assumption that recovery might be accelerated by administration of potassium iodide, Zwerg gave it to some of his patients suffering from actinomycotic lesions in the cervico-facial region, and found that these patients did not recover any sooner than those who were treated with X rays only. He advises against painting the skin of the irradiated area with iodine immediately after irradiation, as this may transform the normal mild aseptic inflammatory reaction of the X rays into very undesirable caustic effects.

Desjardins[60] has tabulated the results of the treatment of 26 proved cases of actinomycosis which affected chiefly the intestinal or pelvic structures or both. In seven cases, lesions were present in both the thorax and abdomen. These cases were observed at the Mayo Clinic between 1920 and 1925. The treatment in most instances consisted of a combination of drainage, the internal administration of iodides and X ray irradiation of the abdomen. Radium treatment was also given in six cases at some time during the subsequent course of the disease. X rays were applied from the level of the xiphoid cartilage to that of the lower border of the pubis, generally through four anterior and four posterior fields. The rays were always generated at about 135 kilovolts, with a focal skin distance usually of 40 centimetres (16 inches), with a filter for anterior fields of four millimetres of aluminium, and for posterior fields of six millimetres of aluminium and five milliampères of current. The time of exposure is not mentioned. Such a course was repeated several times at intervals of three or four weeks. Improvement was not always immediate, and sometimes any distinct evidence of improvement was not noted until after the second or third course of treatment.

Grünthal,[61] in 1927, after a survey of the literature, compiled statistics of the results of combined medical, surgical and X ray treatment in 33 abdominal cases. He excluded entirely all cases in which the liver was involved as well as all gynæcological cases. Of these 33 patients there were 15 or 45% who apparently recovered. In all of the cases the condition was inoperable. In cases in which X ray therapy was used early there was improvement or recovery.

In the course of this study of cases he found that the larger doses of 70% or even 90% skin erythema dose produced better results than the smaller ones of 50% and 70%. In this connexion it should be noted that the dose must be carefully and homogeneously concentrated upon the disease focus, as pointed out by Holfelder. With this in mind, Grünthal used high dosage with excellent results in several cervico-facial cases. The same result was obtained in his case of abdominal actinomycosis. The lower doses which he used in the beginning as a cautious method of testing the value of X rays in this affection, did not show such distinct results as the later higher doses. He agrees with Brockmann, who advises that in inoperable cases all surgical intervention should be limited to incision of abscesses. Repeated operation in inoperable cases results in injury rather than improvement.

X ray therapy has been used in combination with other treatment in actinomycotic infections of the internal female genital organs by Horalek, Schugt (two cases), Haselhorst, Martius, Ahlstrom, Brickner, Bloch, Müller, Blasek, Heim and Daniel.

The patients described by Horalek, Müller, Martius, and Schugt's second patient apparently recovered. The patients described by Horalek and Müller were irradiated after a fairly radical operation had been performed.

Only two applications of small doses of weak intensity were administered a few weeks before death in Haselhorst's[38] case. According to Haselhorst, the prognosis of actinomycosis in the region of the true pelvis is hopeless, when the pelvic connective tissue is involved to any considerable extent. This gives a favourable ground for the rapid development of the process. Because of the deep position in the true pelvis X rays are only slightly effective in the connective tissue of the pelvis. In the indurated parts of the pelvic connective tissue, in which histologically no trace of actinomycosis was found on autopsy, in his opinion recovery in these areas may be attributed to spontaneous healing rather than to X ray treatment.

In Bloch's[55] case the X ray treatment was incomplete; nine doses of 67·2 r each were administered in 22 days. The author was anxious to administer two or three series of treatment but the patient refused further treatment.

Ahlstrom[62] administered three doses of X rays, the first dose being administered fourteen days before death.

Martius[53] used X rays filtered with 0·5 millimetre of copper and three millimetres of aluminium at 200 kilovolts, and with six milliampères of current in the first series of irradiation treatments, using abdominal and dorsal fields each time. The first treatment of the first series was given with focal skin distance of 35 centimetres, and 150 r delivered to each field. The second, third and fourth treatments in the first series were given with a focal skin distance of 50 centimetres and 50 r per field, delivered at seven, six and four day intervals. The depth dose in the middle between the two fields in the first irradiation

was equal to 196 *r* or 30% of the skin erythema dose, assumed to be 660 *r,* as defined by Wintz. Five weeks later a second series of four treatments was given at two, three and two day intervals, with a focal skin distance of 50 centimetres, 50 *r* being delivered per field. The depth dosage used in each treatment was 10% of the skin erythema dose, as in the second, third and fourth treatments of the first series.

The author attributes the favourable result of his treatment to the careful regulation of the dosage used. He believes that the potassium iodide therapy and medication with "Yatren" and "Radiophan" also used in treatment contributed only in a small measure to the apparent cure of his case. After every irradiation treatment there was definite improvement in the affected area. He maintains that the safe and effective treatment of actinomycosis of the female genital organs is removal of all the diseased tissue possible by operative measures, followed by irradiation treatment, small doses being used.

Schugt's[63] first patient was given X ray treatment seven weeks after the incision of an abscess above the right lateral inguinal region. Potassium iodide was also administered by mouth. X ray irradiation was directed toward the right parametrium. There was one abdominal and one dorsal field, each 19 by 20 centimetres, with a focal skin distance of 50 centimetres, a lateral field 11 by 20 centimetres, with a focal skin distance of 30 centimetres, a spark distance of 47 centimetres. a filter of 0·5 millimetre of tin and two millimetres of aluminium. The depth dose was 50% of the erythema dose. Irradiation was repeated about eight weeks later, and was followed later by an exploratory operation. The patient died, and autopsy confirmed his belief in the favourable effects of the X ray treatment on the actinomycotic lesion. The genital organs, particularly the right parametrium, in which infiltration was palpable during life, were free from pathological changes. Only in one fistulous passage at the lower edge of the field of irradiation could actinomyces colonies still be found after considerable search. Schugt concludes that the actual cause of death was secondary infection, whereas the actinomycotic infection was well on the way to recovery.

Schugt's[64] second patient apparently recovered with X ray treatment and potassium iodide given by mouth. Fifteen weeks after posterior colpotomy had been performed, X ray treatment was given in the region of the left adnexa over a field 15 by 13 centimetres, with a focal skin distance of 30 centimetres, a filter of 0·5 millimetre of zinc, and a skin dosage of 150 *r.* The depth dose was about 10% of the skin erythema dose (the skin erythema dose = 500 *r*). Eighteen weeks later three X ray treatments, each of 110 *r,* were given at three week intervals from posterior and anterior directions, large fields being used, with a focal skin distance of 40 centimetres, a filter of 0·5 millimetre of zinc, making a total of 330 *r* per field. The depth dose administered was 20% of a skin erythema dose per sitting. Nine weeks later two treatments were given at three week intervals, through anterior and posterior fields of 11 by 21 centimetres, with a focal skin distance of

50 centimetres, a filter of 0·5 millimetre of zinc, making a total of 150 r in each field. The depth dose was 20% to 25% of a skin erythema dose.

In regard to X ray technique, Schugt recommends relatively small doses administered over a long period of time, maintaining that the mild biological effect upon the ovarian function is also in favour of this procedure, the amenorrhœa produced as a result of treatment lasting only a short time.

Heim[54] also believes that the use of maximum doses of X rays, up to 90% and 120% of a skin erythema dose, depth dosage as recommended by Holfelder, Jungling and others, seems a doubtful procedure in the treatment of female genital infections, even if irradiation is only unilateral. He advises to avoid as far as possible the destruction of the remaining tissue in the ovary, even in so dangerous an affection as actinomycosis. He also draws attention to the experiments of Lieske, which showed that X ray irradiation is incapable of checking the growth of actinomyces cultures.

Case Report.

Mrs. McT., aged twenty-six years, was admitted to Mater Misericordiæ Hospital, Waratah, on November 20, 1928.

The history of the patient, narrated in her own words, is as follows:

> I have a lump in my right groin, which gives me no pain. The only ache I have had was when I had dengue fever, which caused the small of my back to ache for a few days; a few weeks after I noticed a lump come in my right groin and an aching pain in my right knee, which has not left me since, so I think the lump must have caused the knee to ache. I seem to have a tired, sleepy feeling on me ever since. I really don't know how the lump in my side first came, but I remember one day lifting a tub of water, which was rather heavy, and felt something tear in my side. About one week after I noticed this lump. It was not sore, or ever gave me pain, only my knee used to ache a lot; the lump felt very hard and is getting bigger and harder. I thought it was not natural for a lump like that to come in my side, so thought I would see a doctor, and went to a doctor, who examined me and said he thought it was an inflamed, swollen gland and advised me to get it out. I went back in a few days' time, and he operated on me and found this lump had come through from inside the stomach, stitched up my side and sent me down to hospital here.

On inquiry I found the "lump" had been present for three months, gradually becoming larger and harder, during which period she had lost 3·15 kilograms (seven pounds) in weight.

Menstruation was regular. The last menstrual period occurred on November 7, 1928. Menstruation was of the twenty-eight day type, of four days' duration, with an average loss, and unaccompanied by any pain or discomfort, although there was a constant slight yellowish-white non-offensive intermenstrual discharge since the birth of her only child six years previously, at which time she was confined to hospital for seven weeks suffering from "septic poisoning of the womb". Her bowels operated naturally, there was no disturbance of micturition, and her appetite was invariably good. She was not subject to coughs or colds, and she had not at any time suffered from headache. She had lived on a cattle station all her life, had seen cattle suffering from tuberculosis and "lumpy jaw", and had often not only bathed in creeks and dams from which these cattle were accustomed to drink, but had occasionally actually drunk the water. Inquiry

after operation elicited the additional information that she was not in the habit of using vaginal douches or contraceptives, and also that her husband had not suffered at any time from any penile sore or erosion.

On examination, a healed scar, 2·5 centimetres (one inch) long, was noted just above the lower third of the right inguinal fold and definite hard induration of the skin and subcutaneous tissue extended 5·0 centimetres (two inches) above the inguinal fold from the anterior superior iliac spine almost to the middle line. There was no discoloration of the skin and no localized heat in the mass; the skin and subcutaneous tissue were firmly fixed to the lower abdominal wall; there were no tender areas in the mass and no fluctuation was detected. No hyperæsthesia was present over the mass or down the right thigh. There was no evidence of any recent injury, old wound, open sore or fistula on the right lower extremity, vulval, vaginal or anal regions. There was no infiltration of the vulval or vaginal walls. The uterus was anterior in position; definitely hard thickened tubes could be palpated in either fornix; the right ovary was slightly enlarged. The cervix, which was of normal consistency, was slightly eroded and a thin yellow secretion was observed in the cervical canal. No pain was caused by palpation and the adnexa did not appear to be adherent to other viscera in the pelvis. No abnormality was detected by digital and proctoscopic examination of the rectum. Examination of the urine showed the specific gravity to be 1020, a trace of albumin was present, there was no sugar in the urine, and neither casts nor organisms were found. Examination of the blood showed the Wassermann test to yield no reaction. The erythrocytes numbered 4,200,000, and the leucocytes 7,500 per cubic millimetre. The hæmoglobin value was 85%. The polymorphonuclear cells numbered 74%, the lymphocytes 22%, large mono-nuclear cells 3% and eosinophile cells 1%. Examination of smears did not reveal the presence of Gram-negative intracellular diplococci. A provisional diagnosis of malignant disease of the Fallopian tubes was made previous to operation.

Operation was performed on November 23, 1928. An elliptical incision was made around the inguinal mass. The typical glistening amyloid appearance of infiltrating actinomycosis was found on incising the muscular and aponeurotic layers. The whole of the glandular area, together with portion of the underlying infiltrated muscle and aponeurosis, was removed. The incision was deepened and the peritoneum, which appeared quite healthy, was exposed and incised. No hernial sac could be detected, and no intestine or omentum was found immediately under the incision. On examining the uterus, ovaries and tubes through the lower end of the operation wound, the uterus was found to be normal in size and shape; the right ovary was slightly enlarged, with two small cysts on its surface; both Fallopian tubes were shortened, thickened, uniformly hard and woody in consistency. The appendix, of average size, normal in shape and appearance, without kinks, bands or adhesions, and not occupying a pelvic position, was easily removed. There was no evidence of adhesions to the pelvic organs, no apparent thickening of the round ligaments, no excessive fluid in the pelvis and no evidence of scarring or adhesions on the surface of loops of intestine in the vicinity of the uterus, ovaries and tubes. The incision was extended transversely to permit removal of both tubes and ovaries, and a drainage tube was inserted into the abdominal cavity for 2·5 centimetres (one inch) in the mid-line above the *symphysis pubis*. The operation wound, after applications of hydrogen peroxide and iodine, was closed without drainage. The wound at the site where the tube entered the abdominal wall was sealed with friar's balsam.

The left Fallopian tube was nine centimetres long; the transverse diameter varied from seven to ten millimetres. The right Fallopian tube was 8·6 centimetres long; its transverse diameter was eight to ten millimetres. The lumen of the tube was patent in each case. The tubes, on section, showed distinct thickening of the muscular wall. The surface of the congested mucosa was studded with numerous small greyish-white to yellowish-white bodies or granules of a tallowy consistency. These granules varied in size, the largest being approximately the size of a pin's head and the smallest just discernible with the naked eye. The

inguinal glands were invaded by greyish-black granules, which were subsequently proved to be actinomyces granules.

Increasing quantities of oxygen were instilled into the abdominal cavity through the drainage tube on the second, third and fourth days after operation, and the tube was clamped with artery forceps immediately after each instillation. On the fifth day oxygen was allowed to flow slowly into the abdominal cavity until the patient complained of pain in both shoulder regions. The patient shortly afterwards perspired freely and vomited. The clamp and tube were removed on the fifth day ten hours after the administration of the oxygen.

The cavity of the uterus was irrigated with tincture of iodine, one part in eight, once a day, and vaginal douches of one in eight hydrogen peroxide were given three times a day after the third post-operative day, that is, after additional smears were taken and cervical and uterine scrapings were obtained for examination.

Potassium iodide was given three times a day on the fifth day in doses of 0·6 gramme (ten grains) and the dose was gradually increased to 1·8 grammes (30 grains) three times a day on the tenth day, and was continued until the patient left hospital, when 0·3 mil (five minims) of tincture of iodine (French Codex) in milk three times a day were substituted.

The patient's convalescence was uninterrupted after the fifth day; sutures were removed on the fifteenth day; slight serous oozing was present from the fourth to the eleventh day, and the patient left hospital on the twenty-eighth post-operative day, with an apparently healed wound.

She continued the tincture of iodine in milk for eighteen months after discharge from hospital. Her last communication states that she is enjoying good health and gaining weight. She will, of course, be kept under observation for some time, owing to the length of the interval which may elapse before the disease reasserts itself.

Origin of the Infection in this Case.

The presence of foreign bodies, the use of contraceptives, direct extension from a focus of infection in the abdominal wall and metastatic infection by the blood stream from a distant focus of infection may legitimately be excluded as sources of infection in this case. Although infection from the intestinal tract cannot be definitely excluded, the apparent indolent symptomless nature of the infection, the presence of actinomyces colonies in the right inguinal glands, the involvement of both Fallopian tubes, and the conspicuous absence of adhesions suggest that the infection originated from the cervix rather than from the intestinal tract.

Until recent years the possibility of infection from the vagina or cervix, except in one case of proved infection of the cervix, has been denied by most authors. When it is remembered that the vagina is a cavity into which any organism present in water, air, urine or fæces may be so easily introduced by bathing, coitus or various other means, one cannot readily dismiss the possibility of vaginal or cervical origin of actinomycotic infection of the internal genital organs.

In the case under review, the patient frequently bathed in a dam or in a stream from which cattle infected with "lumpy jaw" were accustomed to drink. Though not unmindful of the probable effect of varying atmospheric conditions on the life of the organism, and despite the fact that an identical causal organism has not been isolated from any suspected cattle in the district, it is nevertheless suggested in this case

that water infected with the discharges of cattle suffering from actinomycosis acting as the vehicle of infection, entered the vagina and thus conveyed the infection to the cervix. Having entered the cervix, the organism either produced an unrecognized primary lesion which allowed the infection to ascend in the lymphatic vessels or directly invaded the lymphatic vessels without producing a lesion. After invading the lymphatic vessels, indirectly or directly, the infection extended to both Fallopian tubes and on the right side eventually extended along the lymphatic vessels of the round ligament to the inguinal glands.

This theory of cervical infection is supported by the following study of the cell reactions and tissue reactions in both tubes by Professor D. A. Welsh.

CYTOLOGICAL AND HISTOLOGICAL EXAMINATION.
(D. A. Welsh.)

A Preliminary Survey and Summary of the Actinomycotic Infection in Both Fallopian Tubes.

The relation between structure and infection in this instance of bilateral actinomycotic salpingitis was interesting and significant. All the structures of each Fallopian tube, except the subserous coat, reacted vigorously but variously to the actinomycotic infection, including (*a*) the epithelium, (*b*) the subepithelial connective and vascular tissues of the mucous membrane, and (*c*) the fibro-muscular wall (see Figure I).

But the most striking phenomenon was that, in addition to the reactions of those fixed tissues of each tube, a great multitude of mobile cells from beyond the tube was attracted to the foci of infection within the tube, and there the cells exercised their special functions and underwent their special developments. Such wandering cells from outside the tubes included representatives of the reticulo-endothelial system (histiocytes) and cells of the leucocyte class (chiefly lymphocytes and plasma cells, but also many neutrophile polymorphonuclear cells). Arranged according to actual numbers and probable priority of arrival, the order of these cell reactions would be: (i) lymphocytes and plasma cells, (ii) histiocytes, and (iii) neutrophile polymorphonuclear leucocytes.

Facts of great significance in regard to the onset and progress of the infection are (*a*) that the infection had developed equally (and therefore probably simultaneously) in both Fallopian tubes, and (*b*) that the older colonies of the actinomyces (and therefore probably the initial foci of the infection) appeared in the connective tissue cores of the epithelial plications and nearer the central or inner parts of those cores rather than towards the outer periphery of the mucosa. Thus, when the elaborate architecture of the mucous membrane was destroyed by ulceration of its covering epithelium, as will presently be described, the colonies of actinomyces and the cell reactions around them were precipitated into the lumina of the tubes.

The most important inference to be deduced from that localization of the initial foci of infection in both tubes is that, in all probability, the infection was conveyed to the tubes by lymphatic channels, and further that the lymphatic channels concerned in this infection were
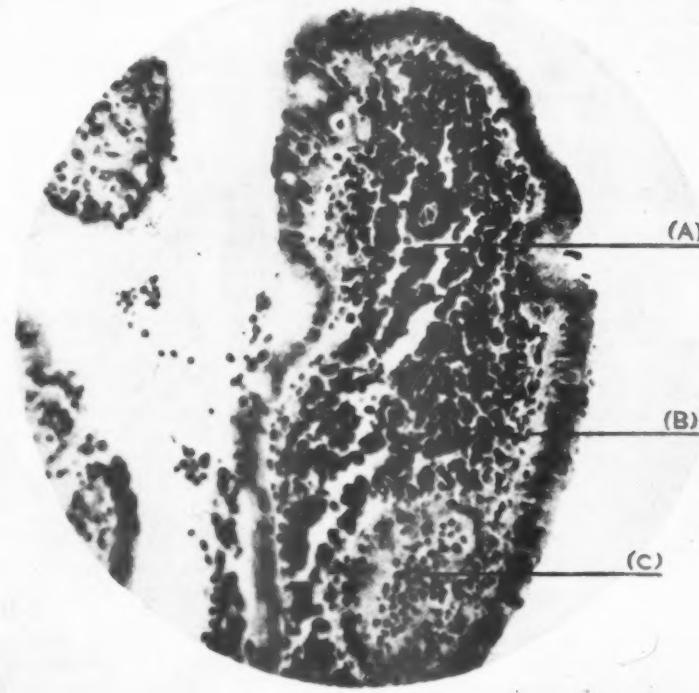

FIGURE I. Cross-section of a tube showing (on the right) the cell reactions in a mucosal plication with the epithelium still unbroken. Note: (A) the massing of the darkly staining plasma cells in the central and apical part of its core, (B) the passing of emigrated neutrophile leucocytes from the subepithelial zone through the unbroken epithelium, and (C) the accumulation of these neutrophile cells alone in a recess of the complicated lumen.   × 260.

not those that come by way of the subserous coat, but were those that come by way of the uterus and cervix. That inference received additional support from the following facts concerning the relative intensity of the cell reactions in different parts of the structure of the tubes.

A concentrated reaction of a highly cellular type developed around the older colonies of the actinomyces as they were met within the tubes. Diminishing reactions of different types developed at increasing distances from those older colonies. Thus the cell reactions attained a maximum where the central extremities of the plications of the mucous membrane had ulcerated and broken down, and their cell products had been evacuated into the lumen. Strong cell reactions were found towards the central ends of many unbroken mucosal plications. Less intense reactions occurred in the deep peripheral recesses between the mucosal plications. Much less reaction could be traced in the perivascular tissues (lymphatics) of the fibro-muscular wall, and there rarely beyond the inner circular layer of muscle, while practically no reaction was recognizable in the subserosa. And always, with this diminishing intensity of the cell reactions at increasing distances from the maximum intensity of the infection in the centre of the tubes, there went a change in the type of those cell reactions. The different cell reactions will be described in more detail later on. Meantime these facts strongly support the previous inference that the actinomycotic infection was delivered to both tubes by lymphatic channels from the uterus and its cervix.

These facts also indicate that the toxic action of the actinomyces on fixed tissues and on wandering cells attains a maximum intensity in the immediate presence of the parasite, and a diminishing intensity at increasing distances from the parasite body. Since no filaments or other traces of the parasite were found at any of those increasing distances beyond the lumina of the tubes and beyond the central parts of the mucosal plications, it would appear: (a) that some form of tissue toxin and cell toxin is liberated from the parasitic body, (b) that the intensity of this toxic action rapidly diminishes with increasing distance from its source of origin (since it was only slight in the fibro-muscular wall), and (c) that the radius of toxic action is very limited (since it did not even reach the subserous coat).

Cell Reactions.

Lymphocytes and Plasma Cells.—An intense cellular reaction to the actinomycotic infection had developed in the subepithelial connective tissue of the mucosa in each Fallopian tube. In studying that reaction with the object of trying to reconstruct the sequence of events, it would appear that the first effect of the arrival of the actinomyces in the tissue was to attract lymphocytes into the infected territory. The evidence in support of the early cell reaction being lymphocytic has to be gathered from the character and distribution of the late cell reactions, as they are now found in both tubes.

The central extremities of many mucosal plications were densely crowded with plasma cells, most of which were abnormal; and, where those central extremities had broken down into the lumen, there were found massive accumulations of plasma cells, all bearing the impress of prolonged extravascular existence and excitation. Heteromorphism

and hyperchromatism were much in evidence among those plasma cells, doubtless due to toxins elaborated by the parasite and most strongly operative in its near presence.

No true giant cells were found, such as are commonly described in actinomycotic lesions; but fusion of enlarged and abnormal plasma cells to form larger cells, each bearing two or three nuclei, was not uncommon. But while enlargement of the plasma cells, with enlargement and blurring of their nuclei, was general, fusion was only occasional.

At those central parts of the tubes, as indicated above, where the cell reactions were at their highest, the proportion of true lymphocytes to plasma cells was very low. At increasing distances from the centres of the tubes the combined aggregate of the lymphocyte and plasma cell invasion became rapidly less, while the relative proportions of lymphocytes to plasma cells increased and only normal well formed plasma cells were met. Finally, in the perivascular lymphatic spaces of the fibromuscular wall, where the last traces of the cell reaction were apparent, that reaction was limited almost wholly to lymphocytes.

Macrophages (Histiocytes and Monocytes).—A remarkable phase of the cell reaction in this actinomycotic salpingitis was the extraordinary response of the histiocytes. These wandering cells of the reticuloendothelial system had immigrated in vast numbers, being outnumbered only by the plasma cells. Histiocytes were literally swarming both in the lumina of the tubes and in the subepithelial stroma of the mucous membranes, but not beyond the outer limits of the mucous membranes. Thus they did not accumulate in the muscular walls, where the perivascular outposts of lymphocytes and plasma cells were found.

When the summits of the mucosal plications and their cell contents had broken down into the central lumen, histiocytes and plasma cells jostled each other in dense crowds; and, mingling with them in inextricable confusion, were many neutrophile leucocytes, some red blood cells (hæmocytes) and a few lymphocytes. Here many of the histiocytes (macrophages) were ravenously phagocytic, ingesting red cells and other cells sometimes to the point of rupture. Here too the histiocytes showed considerable variation in size and form, but the general tendency was towards expansion and "foaminess" of their cytoplasm.

Where the summits of the mucosal plications had not broken down, the histiocytes had accumulated, in the same relatively high numbers, in the subepithelial connective tissue of the mucosa. But, whereas the lymphocytes and plasma cells were massed towards the central parts of those cores, the histiocytes were distributed more uniformly throughout the whole extent of the cores, so that, towards the basal or peripheral parts, many histiocytes were met alone. Although apart from other members of the general cell reaction, these peripheral histiocytes bore evidence of taking an active part, for their cytoplasm was expanded and "foamy", presumably due to their absorption of lipoid products of cell degeneration and destruction occurring in the central lumen.

These lipoidophile histiocytes are probably equivalent to the pseudoxanthoma cells of earlier writers (compare Watjen[65] and Nürnberger[66]).

But the surprising achievement of the histiocytes was that they were sometimes found in great numbers alone within the lumina of the deep peripheral recesses between the mucosal plications. Now the only other cells which were found alone in similar positions were the neutrophile leucocytes, and their presence there alone could be explained by their being able to penetrate the unbroken epithelium of the mucosa. The question then arose how the histiocytes could succeed in getting there alone in any great number. To my surprise, I found histiocytes actually ploughing their way through the unbroken epithelium to reach the open lumen. Perhaps that is not so surprising after all, since histiocytes, like neutrophile cells, are actively amœboid.

Although this form of the cell reaction has been taken to be one of histiocytosis, it has set another pretty problem. For it is not possible to exclude from this reaction other forms of the macrophage, and notably the monocyte or large mononuclear leucocyte of the blood. But, without prejudice, the evidence is against the monocyte being much concerned in this reaction, since the macrophages which are concerned are on the whole more strongly phagocytic and more actively amœboid than monocytes are likely to be.

Notwithstanding the great multitude of histiocytes that had gathered in both tubes, no giant cell formation was observed. No attempt at fusion of the histiocytes, such as often occurs in actinomycotic reactions, was ever found.

Neutrophile (Polymorphonuclear) Leucocytes.—The chemiotactic attraction exerted by the actinomyces on the neutrophile (polymorphonuclear) leucocytes would appear to be a later development. Emigration of the neutrophile leucocytes was well seen in places where the epithelium was intact. In such places the immediate subepithelial tissue was the seat of a considerable new formation of dilated capillary channels carrying red blood cells and neutrophile leucocytes. Then an obvious sequence of events could be traced. A boundary zone of emigrated neutrophile cells was accumulating close beneath the under surface of the epithelium. Then many neutrophile cells could be seen forcing their way between the epithelial cells, and passing through the whole thickness of the epithelium to reach its free surface and gather in the lumen. In some of the deep peripheral recesses, formed by the complicated mucous membrane of the tubes, neutrophile leucocytes were the only cells present in the exudate. It was obvious that lymphocytes and plasma cells could not penetrate the intact epithelial lining of the tubes (see Figure II).

But, with the ulceration of the epithelial lining and the destruction of the central extremities of the mucosal plications, the scene was changed. The accumulated reactions of lymphocytes and plasma cells were thrown *en masse* into the lumen together with the older colonies of actinomyces, while the neutrophile reaction culminated in the

formation of beds of neutrophile polymorphonuclear leucocytes around those older colonies. And among the cellular accumulations in the lumen there would occasionally be met a large expanse of neutrophile cells heralding the near approach of a colony of the actinomyces.

FIGURE II.   Two colonies of actinomyces free in the lumen of the tube stained by Gram.   The cell aggregate in which the colonies are lying has not formed true pus, but consists of a zone of neutrophile leucocytes nearest the colonies and more distant masses of plasma cells and histiocytes, both in great profusion, together with a few lymphocytes and red blood cells.   × 58.

No neutrophile cells were met beyond the outer limits of the mucous membrane. In particular, none were seen in the fibro-muscular wall. Those facts would indicate that neutrophile cells are less sensitive than lymphocytes and plasma cells to the more remote toxic influences of the parasite, and that probably a greater concentration of the toxin is required to call them forth.

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Although large beds of neutrophile leucocytes had accumulated around the older colonies of the actinomyces, quite definitely there was no true pus, nor any evidence of suppuration, such as is characteristic of many actinomycotic infections. These leucocytes were all well preserved. There was neither necrosis of tissue nor autolytic softening of the leucocytes, which is the essence of suppuration. Therefore, both in respect of the non-formation of giant cells and in respect of the non-formation of pus, this particular actinomycotic reaction was somewhat exceptional.

Reactions of the Fixed Tissues of the Tubes.

The Epithelium.—The epithelium reacted to two types of toxic action: (*a*) destructive and (*b*) stimulant. On the summits of many of the mucosal plications the epithelium was exposed to the maximum toxic effects of the actinomyces, and was there destroyed by processes of catarrh followed by ulceration. The consequences of that destructive process to the cell accumulations beneath the epithelium have already been described. In the deep peripheral recesses between the mucosal plications, the destructive action of the parasite was less intense, but its irritant and stimulant toxic effects were more manifest. The result was in places to cause such a proliferation of the peripheral epithelial recesses as to simulate a glandular formation.

The Connective and Vascular Tissues.—The connective and vascular tissues of the subepithelial stroma both doubtless reacted to the toxin. But any connective tissue reactions were overwhelmed by the energy of the attraction for lymphocytes and plasma cells, and were obscured by the dense multitudes of those cells. The vascular endothelial reaction resulted in an abundant new formation of capillary blood channels at the summits of those mucosal plications which bore the brunt of the actinomycotic infection. And, when those summits were destroyed by toxic action, the capillary zone was laid bare. Then some capillaries ruptured, shedding small hæmorrhages into the contents of the tubes, while other intact capillaries followed the cell products into the lumen to vascularize them.

The Muscular Walls.—The muscular walls of the tubes were obviously passing beyond the range of the toxins generated in the centres of the tubes. The diminishing accumulations of lymphocytes in the perivascular lymphatic tissues of the inner circular layer have already been noted. The reaction of the fixed tissues resulted in some chronic overgrowth of the intermuscular connective tissue, causing some fibrotic thickening and induration of the fibro-muscular wall.

The Subserous Coat.—The subserous coat was not noticeably involved in any reaction, presumably because it was beyond the limited range of toxic action.

Vermiform Appendix and Ovaries.

The vermiform appendix and both ovaries were examined for traces of the actinomycotic infection, but no evidence of that was found. In

particular, the cell reactions and tissue reactions, so conspicuously present in both Fallopian tubes, were completely absent in those other structures.

BACTERIOLOGICAL EXAMINATION.

The specimens were unfortunately placed immediately on removal in cotton wool saturated with formol-saline (formalin 40%, 10 cubic centimetres, and 0·9% saline solution, 90 cubic centimetres).

On microscopic examination of a crushed and unstained granule, it was found to consist of a radiating felt-work of mycelial filaments showing true branches with terminal distensions or clubs.

Other granules were crushed and stained by the Gram method with a counter-stain of dilute carbol fuchsin, and were found to consist of numerous filaments and parts of filaments entangled and lying at all angles to one another; the filaments were not straight for any distance and showed numerous true branches; some of the filaments had a terminal distension or club. There was a marked variation in the manner in which the filaments and clubs retained the violet stain of the Gram method; in some the protoplasm was not uniformly stained by the Gram stain and showed light and dark violet stained areas, while in others the filaments and clubs had a Gram-positive, granular appearance. The coccus-like bodies or granules in the protoplasm of the filaments and the clubs varied in size and number. In some of the filaments the protoplasmic granules were arranged in a chain with regular intervals between them; in others the granules gave the filaments an irregular appearance. The Gram-positive granular filament in some cases extended into a large Gram-negative club. There were also a few filaments and a number of clubs that were Gram-negative. There was also a marked variation in the diameter and length of the filaments and the size and shape of the clubs. Microscopic preparations made from the primary granules and later from cultures were non-acid fast.

These granules corresponded in colour, consistency, size, shape, staining reactions and structure to the granules or *"Drusen"* found in actinomycosis.

An attempt was made to obtain cultures from the left and right Fallopian tubes eight hours after operation. The specimens had been removed from the formol-saline saturated cotton wool three hours previously. The left tube was incised freely for examination prior to an attempt being made to obtain cultures, while the right tube had been practically untouched. Tubes of stab agar and shake agar (65 millimetres deep), broth and glucose broth (37 millimetres deep) and sloped agar were inoculated with granular material from both Fallopian tubes, and incubated at 37° C. under aerobic conditions. No growth was obtained in any of the culture media inoculated from granules in the left Fallopian tube even after six weeks' incubation.

Growth from granules in the right Fallopian tube was obtained along the line of inoculation in stab agar after five days' incubation; this growth was discernible only with a hand lens and commenced

30 millimetres from the surface of the medium and extended downwards for 20 millimetres; between this point and the bottom of the tube there was no growth, although in inoculating the media the platinum needle had been passed to the bottom. The growth was more or less similar to translucent balls. After ten days' incubation this growth had the appearance of a nodular greyish-white mass in the form of a tapering string of irregular balls; the largest ball was at the top of the growth, and measured 1·5 millimetres in its greatest diameter; and in twenty-nine days this ball had reached its maximum diameter of 7·5 millimetres. The maximum growth occurred 30 millimetres from the surface, at which depth a trace of oxygen is present, and ceased 50 millimetres from the surface, at which depth no oxygen is present, thus demonstrating rather well its micro-aerophilic character. With the exception of two tubes of shake agar, in one of which there was one colony and in the other six colonies, no growth occurred in any of the other tubes of culture media even after six weeks' incubation at 37° C. The colonies in shake agar were noticed after 21 days' incubation growing 15 to 20 millimetres from the surface of the media as greyish-white irregular mulberry balls, measuring 0·5 to 1·0 millimetre in diameter.

Microscopic examination of the preparations made from the stab agar and shake agar primary cultures stained by the Gram method with a counter-stain of dilute carbol fuchsin showed them to be pure cultures of an organism having morphological characteristics similar to those of the organism in the primary granules.

In later cultures some of the filaments had a subterminal distension. Some of the subterminal and terminal distensions or clubs appeared to give rise to short filaments.

In older cultures the granules in the bacterial protoplasm are fewer than in young cultures, though larger in size.

Inoculated tubes of broth and glucose broth 37 millimetres deep, sloped agar and inspissated serum showed no growth even after six weeks' incubation at 37° C. under strict aerobic conditions.

Stab subcultures in agar, glycerine agar and glucose agar (65 millimetres deep), incubated at 37° C. under aerobic conditions, showed the same cultural characteristics as those of the primary agar stab culture, though it was observed that growth takes place at from 25 to 30 millimetres from the surface, depending on the size of the puncture made with the platinum needle; the smaller the puncture the nearer the surface the growth, the larger the puncture the farther from the surface the growth takes place.

Shake agar, shake glycerine agar and shake glucose agar subcultures (65 millimetres deep), incubated at 37° C. under aerobic conditions, showed a growth in five to seven days, 15 millimetres below the surface. In the zone above this point no growth took place. If an alkaline glucose methylene blue oxygen indicator is incorporated in similar tubes of uninoculated media, this zone is found to correspond to the zone of oxidation. In the lowest portion of this zone of oxidation there is

a zone approximately two millimetres wide in which the maximum number of colonies appear; below this the colonies become fewer, until a depth of 40 to 45 millimetres is reached. From this point to the bottom of the tube there is no growth, thus demonstrating its micro-aerophilic character. On examination with a hand lens the colonies appear in five days as biconvex translucent discs, and in 10 days as greyish-white irregular mulberry balls varying in size from 0·25 to 0·5 millimetre in diameter.

A gelatine liquid subculture 50 millimetres deep, incubated aerobically at 37° C., reached its maximum growth in five weeks, and appeared as a greyish-white irregular mulberry ball at the bottom of the tube, measuring nine millimetres in its greatest diameter.

The optimum depth of media for growth in liquid subcultures was found in broth and glucose broth subcultures to be 37 millimetres under a six millimetre seal of liquid paraffin; in broth and glucose broth subcultures 50 millimetres without liquid paraffin.

When these were incubated aerobically at 37° C., the subcultures reached their maximum growth in four weeks, and showed as small balls of coarse wool in the bottom of the tubes. No turbidity was produced in the medium. There was a tendency in later subcultures— about the tenth generation—in broth and glucose broth under liquid paraffin, for the growth to extend up the wall of the tube.

It was found that no growth occurred if the depth of media in the tubes without a six millimetre seal of liquid paraffin was decreased to 37 millimetres or increased to 75 millimetres. It was also found that no growth occurred if the depth of media in the tubes with a six millimetre seal of liquid paraffin was decreased to 25 millimetres or increased to 50 millimetres, or if the depth of the seal of liquid paraffin was varied from six millimetres.

Slope agar subcultures placed under carbon dioxide tension (Rockwell's method)[67] and incubated at 37° C., showed in seven to ten days, on examination with a hand lens, as minute greyish-white irregular convex discs with a root-like penetration of the surface of the media; the colonies reach their maximum growth (0·5 to 1·0 millimetre in diameter) at the end of four weeks. The colonies were not resistant when touched with the platinum needle. It was found particularly with sloped agar that, if the tube of the media was heavily seeded, little or no growth occurred, generally the latter, whereas, if one seeded sparsely, a moderately good growth was obtained.

The reaction of media employed was pH 7·6.

Care must be exercised in the manipulation of macroscopic granules and cultures for microscopic preparations, as the filaments have a tendency to break up very readily into fragments, so as to resemble bacilli and cocci. Growth can take place from these parts of filaments when cultured.

Cultures in broth under a seal of liquid paraffin incubated at 37° C. for four weeks and kept at room temperature for ten months, were

found to be still viable upon subculturing; cultures kept in the ice chest for the same length of time were not viable and did not grow even after six weeks' incubation at 37° C.

The organism has been subcultured up to the present time, that is, over five years.

Growth did not take place in the cool incubator at 22° C. The optimum condition for reproduction *in vitro* appears to be at 37° C. in media suitable for a microaerophilic growth.

To see if incubation under strict aerobic conditions had any inhibitory action on the organism, 15 tubes of sloped agar were seeded with a viable culture; three of these tubes were placed under carbon dioxide (Rockwell's method) as controls and all the tubes were incubated at 37° C.; at intervals of ten days, three of the aerobic tubes were placed under carbon dioxide and incubated for a further six weeks, and it was found that growth occurred only in the three control tubes, showing that exposure to the amount of oxygen in the air for ten days was sufficient to kill the organism.

The organism is definitely variable in its morphological and cultural characteristics.

Microscopic preparations and tubes of media inoculated from the teeth, tonsils, appendix, uterus, ovaries, cervix and vagina failed to show the organism of actinomycosis.

INOCULATION EXPERIMENTS.

In available literature, with the possible exception of four instances, there is no evidence of success in the production of progressive lesions as the result of experimental inoculation of animals with cultures of an organism morphologically and culturally similar to this organism.

We, ourselves, found that when cats, guinea-pigs and white rats were inoculated intramuscularly and intraperitoneally with subcultures of the third generation, the experiments failed to produce progressive lesions when the animals were killed at intervals of from six to twelve weeks.

Guinea-pigs, inoculated with shake agar cultures into the abdominal cavity through a mid-line incision, did not show any progressive lesions when killed four months later.

In an endeavour to find a reason for the failure to produce progressive lesions in inoculated animals, experiments were conducted on guinea-pigs, which showed that the organism was excreted from the blood stream into the bile and urine; cultures of the organism were obtained from these sources. On microscopic examination of the urine and bile of inoculated animals, fragments of filaments and clubs were seen within the leucocytes.

Following these experiments broth subcultures were introduced with a syringe into the peritoneal cavity of guinea-pigs the day following the removal of the spleen and one kidney; guinea-pigs which had the same organs removed were inoculated with shake agar subcultures at the

time of operation, the cultures being placed in the abdominal cavity. No progressive lesions were found on killing these animals at periods varying from six weeks to six months, although occasionally a localized lesion was found up to three months, but never at a later period.

And, moreover, it was found that results similar to those produced at room temperature were obtained when guinea-pigs, with the same organs removed and inoculated with broth subcultures or with shake agar subcultures, placed in a specially constructed refrigerating cabinet, automatically controlled at 2° C., were killed at intervals of from six weeks to six months.

Then, in order to ascertain whether trauma would aid in the production of a progressive lesion, subcultures which had been grown in tubes of broth containing very fine short tubular pieces of glass were introduced and sutured into the uterus of guinea-pigs through a mid-line incision within a few hours of parturition. These animals also showed no sign of infection when killed six months later.

Subcultures which had been grown in tubes of broth containing sterile wheat were introduced in a similar manner after parturition and also into the abdominal cavity of non-pregnant guinea-pigs. No evidence of infection was found when the animals were killed at intervals of three to six months.

Subcultures which had been grown in tubes of broth containing very fine short tubular pieces of glass, were embedded between the muscles of the thigh in rabbits and white rats, but again no evidence of infection was found when the animals were killed six months later.

Seventy-four animals were used in experimental inoculations, in an attempt to produce a progressive lesion, but without success.

SUMMARY.

A case of actinomycosis of both Fallopian tubes is reported, the causal organism being a filamentous branched clubbed organism, Gram-positive, non-acid fast, which grows in five to ten days under micro-aerophilic, but not under aerobic, conditions.

Actinomycosis is not always a suppurative process.

Infection may be conveyed by lymphatic channels.

The probability of the cervix being the point of invasion or the site of a primary focus of infection of the internal genital organs cannot be disregarded.

One must be ever "actinomycosis conscious", as it is frequently not possible to differentiate clinically between lesions caused by the organism of actinomycosis and those produced by almost any other organism.

The paucity of cases reported is doubtless due to the fact that routine microscopic examination of specimens removed at operation or at autopsy has been neglected.

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[*A précis of the available literature on actinomycosis of the female genital organs to the end of 1932 has been made by Dr. Gardiner, and this précis, together with the translations of literature, has been deposited in the library of the Royal Australasian College of Surgeons (which is now open), and is available on application to anyone who is interested in the subject.*]

Surgical Technique.

PLASTIC REPAIR OF PATULOUS ANUS BY MEANS OF FASCIA LATA STRIPS.

By E. Cato,
Melbourne.

ANAL incontinence is a particularly unpleasant affection for the patient and a difficult condition for the surgeon to remedy. Various methods have been devised to deal with it. One of the most satisfactory is the reconstruction of a voluntary sphincter by means of fascial strips attached to the gluteal muscles and by the Wreden Stone technique.

The following is the clinical and operative history of an old woman of seventy, suffering from an anal incontinence due to prolapse, who was successfully treated by this method.

For twenty years the patient had complained of a prolapse of the rectum, which had been gradually getting worse, until the present, when it has become very bad. Figure I shows the extent of the prolapse. For fifteen years the

FIGURE I.

FIGURE II. A and B have been marked in with iodine, and are the two incisions necessary to expose the *gluteus maximus* on either side. C is the dimple remaining in the middle of the scar following the Lockhart Mummery operation. X and X are the incisions below and above the anus to enable *fascia lata* strips to encircle the anus in opposite directions.

patient had existed in a wheel chair, and, if any attempt were made to walk, the rectum immediately protruded. In fact, the rectum prolapsed during any exertion. She defæcated on her side, and, following this, it took a considerable time to return the prolapsed mass to its normal position. When the prolapse was reduced, the anus admitted four fingers with ease, and there was no sphincteric action of any kind. The patient had a very poor general muscular tone, undoubtedly due to old age combined with a loss of general muscular function, the result of enforced idleness.

On April 3, 1933, under ethylene anæsthesia, a preliminary sigmoid colostomy was made.

On April 27, again under ethylene anæsthesia, an incision was made posterior to the anus. The rectum was dissected from the sacrum posteriorly and also laterally, and the cavity was loosely packed with gauze soaked in glycerine, after the method of Lockhart Mummery.[1]

Two months later, the operation for the reconstruction of a voluntary sphincter, after the method of Wreden Stone, was performed.

The steps of the operation were as follows:

1. The patient was placed in an exaggerated lithotomy position.

2. The field of the operation was most carefully prepared by appropriate antiseptic treatment.

3. Incisions were made on each side along a line from the coccyx to the tuberosity of the ischium (Figure II, A and B).

FIGURE III.

These were about three centimetres l o n g, a n d through them the mesial margin of the *gluteus maximus* muscle was exposed. A bundle of fibres of each *gluteus maximus* muscle, about two centimetres thick, was now separated in the long axis of the fibres, but was not detached, so that it formed a band of muscle.

4. Two more incisions were now made: short deep stabs just in front and just behind the anus (Figure II, X and X).

5. These four wounds were connected with each other by forcing a closed curved forceps through the subcutaneous tissue from one wound to another (Figure III).

6. Through the tunnels thus formed two strong lines of thread, to which were tied strips of fascia, either of Koontz's prepared fascia or strips of the patient's own *fascia lata*, were pulled in the following way (Figure III). Each thread started from one of the lateral incisions, and was made to encircle the anus subcutaneously, but in opposite directions, each forming a separate loop. The strips of fascia were pulled through these channels, the loop of redundant thread left projecting from incisions B and C in Figure III facilitating the process. The two corresponding ends of each strip, which pass above and beneath the isolated bundle and gluteal muscle fibres, were pulled taut, so as to close the anus, and were sutured together about the muscle as shown in Figure III. These loops were so tightened that the anal outlet was closed snugly.
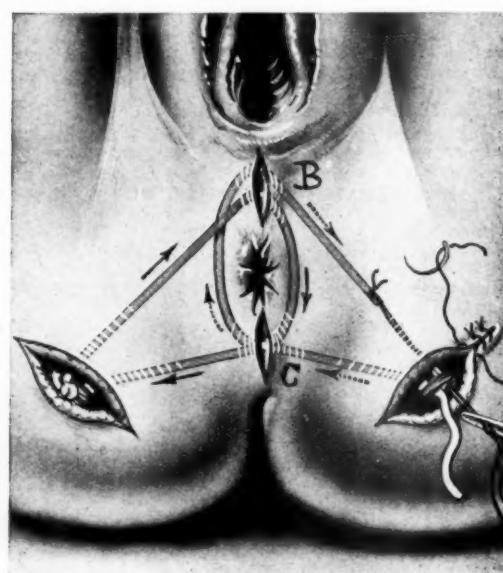
The wounds were closed in the usual manner. The patient's bowels were kept confined for nine days.

In this operation, as the gluteus muscles must be voluntarily contracted so as to pull the loops still tighter and give a mechanism for voluntary increase in closing the anal canal, instructions to the patient are an important factor in its success. Accordingly, the patient was instructed how to contract the buttocks when necessary.[2] The patient is now able to walk about in comfort and has complete control of the anus. The sigmoid colostomy closed naturally. Figure II shows the patient when she was just about to leave hospital.

References.

[1] Lockhart Mummery: "Disease of the Rectum and Colon", page 246.

[2] F. W. Rankin, J. A. Bargen and L. A. Buie: "The Colon, Rectum and Anus", 1932, pages 808, 809, 810.

A SAFEGUARD FOR THE DANGER AREA IN THE RAMMSTEDT OPERATION FOR CONGENITAL HYPERTROPHY OF THE PYLORUS.

By JAMES A. JENKINS,

Dunedin.

THE only difficult part of the Rammstedt operation is encountered when the duodenal end of the obstructing mass is being dealt with. Fear of tearing into the duodenum is ever present in the operator's mind, and may readily lead to a few fine, thought resistant, fibres being left at the mucosal angle.

In the operation that I perform, the usual procedure is followed until the hypertrophied mass is split down to the shining submucosa, and this is sufficiently freed to allow it to balloon forward through the pyloric incision. Care is taken to avoid the dangerous area in this separation. The anæsthetist passes a soft rubber catheter down the œsophagus into the stomach (a 10 to 12 English catheter with olivary end is preferred), and this is manipulated by holding it through the stomach wall. The olivary end of the catheter is gently passed along the pyloric canal and coaxed into the duodenum. It ruptures the few strands in the dangerous area which are so liable to be a post-operative source of retention, and which cause concern when the attempt is made to divide them from the peritoneal aspect. It is interesting to note that in cases in which the ordinary technique has been carried out, on passing the catheter there is a very definite obstruction which yields to a little pressure. Once the catheter has passed, the surgeon can finish the operation with the certain knowledge that the infant has a patent outlet from the stomach.

The catheter is withdrawn from the stomach by the anæsthetist once dilatation has been effected.

The extra time taken does not amount to more than one or two minutes, and the surgeon is amply rewarded by the smooth post-operative course.

Case Reports.

HYDATID CYST OF THE PANCREAS.

By D. B. WALKER,
Rockhampton, Queensland.

Case. I.

S.W., A MALE, aged thirty-two years, was admitted to the Rockhampton General Hospital on February 15, 1933, with a diagnosis of an enlarged gall-bladder. Two days before admission he felt a "dull, steady pain" in the epigastrium. It was localized, not very severe, and had not varied during the two days. There had been some nausea and belching, but he had not vomited.

His appendix had been removed in 1921. For some months he had suffered from vague abdominal pain, with belching of wind, and had noticed some fullness in the upper part of the abdomen. Otherwise he had always been healthy. He had never been outside the Rockhampton district.

On examination the patient was a coloured man, of normal build and healthy appearance. In the epigastrium was felt a tense, smooth, cystic swelling about the size of the fœtal head; about two-thirds of the swelling lay to the left of the mid-line. The lower border almost reached the umbilicus. It was globular, slightly tender, and did not move on respiration. Stomach resonance separated it from the liver dulness above. No other abnormality was found. The diagnosis made was "a cyst or collection of fluid in the lesser sac". At operation on February 16 a cyst was found projecting forward between the stomach and the transverse colon. An opening was made through the gastro-colic omentum, when the cyst was found to be covered by the peritoneum of the posterior wall of the lesser sac. It contained clear, watery fluid and no daughter cysts were present. On collapse of the cyst wall, the endocyst had merely to be lifted out with sponge forceps. The cyst was fixed posteriorly to the body of the pancreas. The cyst was marsupialized and drained. The patient was discharged, with the wound healed, on March 21, 1933. No cysts were seen in the liver or other abdominal organs.

Case II.

Mrs. E.S., aged thirty-six years, was first seen on April 27, 1933. She stated that she had had a swelling of the left side of the abdomen for six years. For two years before she first felt the swelling she had suffered from pain in the left groin—"a nagging pain", which came on at intervals of a few weeks, and lasted a few days. This, together with pain in the tumour itself, had become more constant and more severe during the last two years; she had required morphine on three occasions. During these two years the swelling had become much larger. For several weeks before I saw her she had had much less pain; in fact it had almost disappeared.

She first felt the tumour to the left and below the umbilicus. It appears that what she felt was the lower margin, since she had never noticed any upper limit. She also stated that the swelling varied in size, and that the increase in size coincided with the attacks of severe pain. She had been told by several medical men that she had an enlarged spleen.

There was a history of typhoid fever in 1917; otherwise she had had no illness. She was born in central Queensland, and, apart from an occasional holiday in Sydney, had never lived elsewhere.

On examination she was a healthy looking woman of medium build. There was a marked prominence of almost the whole of the left side of the abdomen. Palpation revealed a large, smooth, tense cystic swelling extending from the left costal margin to the level of the anterior superior spine. It extended five centimetres (two inches) to the right of the umbilicus, and by gentle pressure backwards could be felt in the left kidney region. The right margin was rounded, not sharp or notched, while the fingers could be pressed between the upper border and the costal margin. There was normal resonance over the left lower ribs and between the tumour and the liver. No other abnormalities were detected, and examination revealed a normal blood picture.

As the patient gave a history of variations in the size of the tumour, it was at first thought to be a large hydronephrosis. An intravenous pyelogram, however, showed the left kidney to be normal, though displaced slightly upwards. The patient had to return home for some weeks, and during that period there was no pain, nor did variation in size take place.

On June 1 the abdomen was opened by a left paramedian incision. A large cyst was found projecting between the stomach and transverse colon. The spleen was felt to be normal, and no other cysts were seen or felt. The transverse colon was displaced downwards, and was lying at the level of the sacral promontory. The gastro-colic omentum was thinned out, and the stomach was resting on the upper surface of the cyst. When the gastro-colic omentum had been incised the cyst was found to be covered by peritoneum of the posterior wall of the lesser sac.

An exploring syringe withdrew turbid, but odourless, fluid, and the contents were evacuated by means of a sucker. They measured a little over 1,800 cubic centimetres (three pints). There were no daughter cysts. The endocyst was somewhat injected, and was adherent to the adventitia, so that it did not separate spontaneously on evacuation of the fluid. The adventitia was also much thicker than that of Case I, and was attached posteriorly to the pancreas for almost the whole of its length and to the upper surface of the transverse mesocolon for two or three inches. A large rubber tube was fixed by purse-string sutures into the sac, and the sac was sutured to the abdominal wound. A few days later the sac was irrigated with 1% formalin, followed by saline solution, to destroy any remaining membrane, and a few days later several small pieces of membrane were discharged. Culture of the fluid showed it to be sterile.

The patient was allowed to go home on June 22 for domestic reasons. There was then a moderate amount of this discharge. In a letter received from the patient (July 24) she stated that the wound had "pretty nearly closed".

She came to see me again on September 11. The opening into the cyst was closed. She stated that there had been profuse discharge at intervals, and that the opening would close after each discharge. The cyst was a little more than half its original size, but the wall was so thickened that it felt like a solid tumour.

Under an anæsthetic the opening was enlarged with the finger, and the wall was then felt to be quite 3·75 centimetres (one and half inches) in thickness. There was a profuse dirty brownish discharge, without odour. A large drainage tube was inserted.

The same copious brown coloured discharge kept up for several weeks, and during this time the temperature rose daily to 38·9° to 40° C. (102° to 104° F.). But signs of toxæmia were not marked, the tongue remaining clean and moist. The mass became more solid, and began to bulge above the drainage tube. About November 20 the skin above this bulge became red and tender, and about a cupful of frank pus was evacuated, apparently from an overlooked loculus. The mass gradually became more painful, and her condition deteriorated until she died on December 5. Unfortunately, no *post mortem* examination was obtained.

Comment.

Hydatid cyst is very rare in the pancreas. Moynihan[1] (quoting Albo) states that only twenty-four cases had been recorded up to 1922. Hydatid infection is uncommon in Queensland. I have been unable to discover when the last case

was treated at the Rockhampton Hospital, but it is certainly over eight years ago. Case I was a simple uncomplicated cyst, and, apart from its situation, the only feature worth noting was the absence of daughter cysts. There was no history of injury, and apparently no communication with a duct of the pancreas, facts which support Dew's views regarding the formation of daughter cysts. In Case II the fluid was turbid but sterile. In his book on hydatid disease, page 235, Dew[2] writes:

It is sometimes difficult to be sure whether the cyst is suppurating, as many degenerated cysts contain fluid which strongly resembles pus.

And on page 236 he writes:

In some of these cases it is possible that a low grade infection has occurred, but that just as occurs with salpingitis the organisms die out, and that although pus is present there are no toxic symptoms and no organisms are grown on culture.

In this case the attacks of pain, coinciding with some increase in size of the cyst, the turbid fluid, the slight congestion of the endocyst and laminated membrane and their fixation to the adventitia, together with the more rapid growth of the cyst for two years after the pain in it began, appear to me to point to such a low grade infection. If this is so, it would appear to have been a blood-borne infection, since there was no evidence of any communication with a pancreatic duct. Presumably the organisms died out several weeks before the patient was first seen, when the pain ceased.

I regret that in neither case were any of the special tests for hydatid disease carried out.

References.

[1] Moynihan: "Abdominal Operations", Fourth Edition, Volume ii, page 484.
[2] H. R. Dew: "Hydatid Disease", pages 235 and 236.

J

CONGENITAL VALVULAR OBSTRUCTION OF THE POSTERIOR URETHRA.

By GLEN H. BURNELL,
Adelaide, South Australia.

ALTHOUGH Langenbeck described congenital valvular obstruction of the posterior part of the urethra as early as 1802, and Tolmatchew again in 1870, it was not until 1919, when Young, Frontz and Baldwin[1] described a series of twelve cases in detail, with autopsy findings in those patients who died, that it became recognized as a definite clinical entity of some frequency and of considerable importance.

Briefly, the condition is one of obstruction of the posterior part of the urethra in the male by one or more valves or folds of the mucous membrane. These valves may be of three types: (i) A ridge-like fold extending forwards from the verumontanum and dividing into two membranous sheets, which are attached to the sides and floor of the prostatic urethra. (ii) Similar ridge and folds extending upwards towards the internal sphincter and similarly attached. (iii) A diaphragmatic fold with a small aperture which may be central or eccentric.

The last mentioned form may bear no relation to the verumontanum, but may be in any part of the prostatic urethra.

Ætiology.

Several theories have been advanced to account for the formation of these valves:

1. Tolmatchew believed them to be simply enlarged forms of the normal folds of the prostatic urethra.

2. Bazy thought them to represent a persistent urogenital membrane. This is almost certainly incorrect, as the valves are too variable in type and position to be derived from a structure of such constant position as the urogenital membrane.

3. Lowsley believes that the condition is an anomaly of the Wolffian and Mullerian ducts.

It is probable that the first view is the correct one.

Age Incidence.

The valves have been described in a fœtus of five months and in a man of eighty-five years, but the vast majority come under observation during the first two years of life.

Symptoms.

The chief complaint is some disorder of urination: either pain, retention, incontinence or frequency. There may also be complaint of distension of the abdomen, accompanied by loss of weight. Vomiting and other symptoms of uræmia occur in the later stages. Pyuria frequently, and hæmaturia occasionally, occur.

Diagnosis.

If a male infant shows evidence of urinary obstruction with a distended bladder and if phimosis, pin-hole meatus, and urethral calculus can be excluded, the cause of the symptoms is almost certainly valvular obstruction.

The point of obstruction can easily be determined by preparing a cystogram.

It is interesting to note that the valves, while obstructing the outflow of urine, do not offer any resistance to the passage of a sound into the bladder, as they fall back against the sides of the prostatic urethra during the passage of the instrument, only to return to the obstructing position when the sound is removed.

Pathological Anatomy.

The results of the obstruction to the urinary outflow are those incident to any urethral obstruction, namely, a dilated and hypertrophied bladder, bilateral hydroureter and hydronephrosis, with eventual death from uræmia in untreated cases. Should sepsis supervene, death is of course more rapid.

The prostatic urethra shares in the dilatation of the bladder, so that the internal sphincter is usually stretched and incompetent. The dilatation of the ureters is usually asymmetrical, the left one being more dilated than the right. This dilatation may render the ureter as large as small intestine.

Treatment.

Treatment is solely operative. As in all other cases of operation on patients with urinary obstruction, a preliminary drainage should be carried out, while at the same time copious fluids are administered. The drainage may be by urethral catheter or by suprapubic cystostomy.

Before operating the usual renal function tests should be carried out.

The operative approach may be: (a) per-urethral, (b) suprapubic, (c) perineal.

Young has removed the obstruction by means of a tiny urethral punch, but in the majority of cases it will probably be found easier to expose the urethra, either through the perineum or suprapubically, and to excise the valve under direct vision. Addison[2] has recommended that, as the prostatic urethra is always dilated in these cases, the bladder and prostate be mobilized by the division of the pubo-prostatic ligaments, and that the prostatic urethra should then be opened in front of the internal sphincter. This operation is quite feasible, and a modification of it was used in the case which I now report.

Case Report.

D.G., a male infant, aged thirteen months, was admitted to the Adelaide Children's Hospital on April 7, 1933, with the following history. He was quite well until one month prior to admission, when a lump was noticed low down on the left side of the abdomen. It was hard at first, but gradually became softer and less evident. For six days after this onset he had abdominal pain, and was treated as suffering from gastro-enteritis, but there was no diarrhœa, and very little vomiting at this time. He then apparently recovered, and remained well until six days prior to admission, when he had a screaming attack, during which he drew up his legs. This attack lasted an hour, and he did not vomit.

Four days prior to admission to hospital he had another attack, again lasting about an hour, and in this attack he vomited once. His motions had been regular and normal in appearance, there being no diarrhœa at any time, nor was there any history of the passage of blood or slime.

For two days prior to admission to hospital he had been free of pain, but his appetite had been very poor. His mother stated that he grunted when voiding urine, but no other information was obtainable in respect of this function. His previous history had been uneventful, except for the fact that at six weeks of age he had had retention of urine, which had necessitated catheterization.

On examination, he was seen to be a fairly well nourished baby, but had a sallow complexion, and his skin was very inelastic. He had a definite appearance of dehydration.

A general examination revealed no abnormality, except in regard to the abdomen; this was definitely distended just above the pubes, and also in the left iliac fossa. In each of these situations a definite soft swelling could be detected. When pressure was applied to the suprapubic swelling, the swelling in the iliac fossa could be felt to become larger and more tense. Visible peristalsis could be noticed in the left iliac fossa. An enema was given, and returned a normal but constipated motion. The day after his admission to hospital it was noticed that his urine was dribbling away continuously: the urine was clear and free of albumin, sugar or blood.

On April 11, 1933, five cubic centimetres of "Abrodil" solution were injected intravenously and an X-ray examination was made (after plain skiagraphy had failed to reveal anything abnormal). The urograph showed a bladder distended
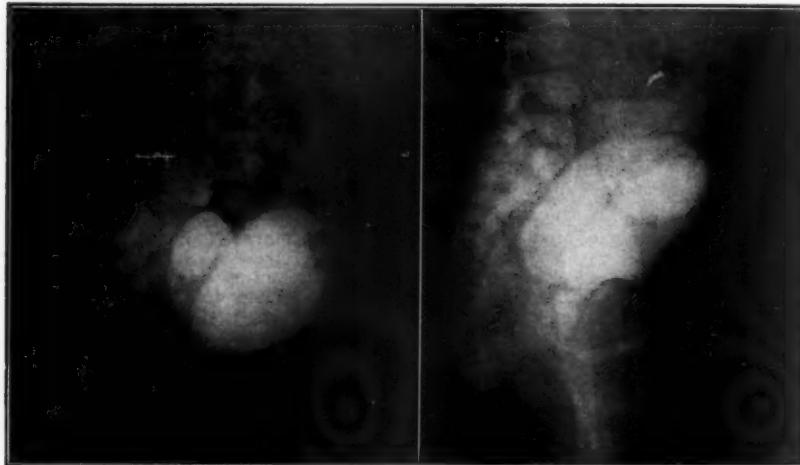
FIGURE I.   FIGURE II.

almost to the umbilicus, but no shadow of kidneys or ureters was seen (Figure I). A diagnosis of congenital valvular obstruction of the posterior part of the urethra was made.

On April 13, 1933, forty-five cubic centimetres of sodium iodide solution were injected into the bladder through a rubber catheter, and further skiagrams were taken. These revealed a grossly distended bladder, and a greatly dilated left ureter (Figure II). The right ureter was not outlined. On withdrawing the catheter, and taking a second X-ray picture, it was seen that the prostatic urethra was greatly dilated, so that it formed a funnel-shaped outlet to the bladder, and established the point of obstruction as being in the prostatic urethra. The diagnosis of valvular obstruction was thus confirmed.

On April 21, 1933, the blood urea was 28 milligrammes per 100 cubic centimetres, and no indigo-carmine was excreted in twenty-four hours.

Owing to the small size of the child, and the absence of any instrument small enough to allow one to punch out the obstruction *per urethram*, it was decided to remove the valve by the suprapubic route. But the child's general condition was so poor that it was evident that prolonged pre-operative drainage would be necessary.

On April 22, 1933, a ureteral catheter was passed into the bladder and strapped to the thigh to hold it in position. Fluids were forced to the limit of

toleration. After the institution of drainage the child's general condition rapidly improved, and on May 1, 1933, he was adjudged fit for operation.

On this date, under ether anæsthesia induced by the open method, the bladder was first opened suprapubically in the usual way. Small sounds were passed *per urethram* in the hope of catching on the valve and indicating the point of obstruction, but without success. A finger could be readily passed into the prostatic urethra through the internal sphincter, which was widely dilated, so it was decided to open the prostatic urethra in front of the internal sphincter, leaving the latter intact. This manœuvre was rendered possible by retracting the base of the bladder firmly with the left hand, while, with the right, one divided the pubo-prostatic ligaments and thus allowed the bladder to fall away from the *symphysis pubis*, this providing sufficient working room for the remainder of the operation.

With the left index finger in the prostatic urethra, the latter was opened in front of the internal sphincter, and the two edges of this incision were held apart with stay sutures. It was then easily seen that the obstruction was due to a large valve running up from the region of the verumontanum to the right wall of the prostatic urethra near the vesical sphincter. There was a similar smaller valve running to the left side of the urethra. The large obstructing valve on the right side was then picked up with forceps and divided, and the smaller left valve was treated similarly. The prostatic urethra was then closed by interrupted sutures of plain catgut. A number 3 Jacques catheter was passed *per urethram* into the bladder and transfixed by a silkworm gut suture, which was brought out of the suprapubic wound; the bladder was closed except for a small drainage tube near the fundus. After the wound in the abdominal parietes was closed, the silkworm gut, which had transfixed the urethral catheter, was tied round a glass rod lying on the suprapubic wound, so that the child could not possibly withdraw the urethral catheter. A rubber tissue drain was inserted into the *cavum Retzii*.

The child stood the operation well, and drainage was free from the first. On May 3, 1933 (two days after operation), the suprapubic tube and drain were removed, but not the urethral catheter, which was left in position until May 9, 1933. As often happens, the removal of the catheter caused a rise of temperature to 37·8° C. (100° F.), but this fell to normal on the next day. He began to void freely and regularly, and the urine was clear and free of pus or blood.

On May 17, 1933, he developed chicken-pox, and was transferred to the isolation block.

On May 30, 1933, the suprapubic wound broke down, and discharged urine freely. A number 6 catheter was passed *per urethram* and tied in position.

By June 6, 1933, the suprapubic wound had closed again, and the catheter was removed.

On June 22, 1933, the blood urea nitrogen test revealed thirty-three milli-grammes per hundred cubic centimetres.

He was discharged on June 23, 1933, quite well and voiding freely. His weight at this time was 7·86 kilograms (17 pounds 7 ounces).

He was seen again in November, 1933, when his weight was 11·49 kilograms (25 pounds 8 ounces), representing a gain of 3·63 kilograms (8 pounds 1 ounce) in five months. His parents were asked to leave him for observation for twenty-four hours, and the ward sister reported that he voided urine nine times during the day and not at all at night. At this time no suprapubic or iliac swelling could be seen or felt, and his skin had regained its normal elasticity. A specimen of urine contained no albumin or pus. He was shown at the meeting of the Royal Australasian College of Surgeons in February, 1934, and had continued to gain in weight and health.

Comment.

In view of the extensive damage to renal function, which had already occurred when the child came under observation, it is doubtful as to what

the ultimate outcome will be. It will be seen that after the operation the blood urea nitrogen was 33 milligrammes *per centum*, as opposed to 28 milligrammes prior to operation. But the improvement in the child's general condition was dramatic, and it is hoped that, following the release of tension within the urinary tract, the kidneys may regain a considerable degree of function.

In future cases I think it might be feasible to open directly into the prostatic urethra without opening the bladder, but certainly the presence of a finger in the prostatic urethra facilitated its exposure.

References.

[1] H. H. Young, W. A. Frontz and J. C. Baldwin: "Congenital Obstruction of the Posterior Urethra", *Journal of Urology*, Volume ii, 1919, page 289.

[2] Oswald Addison: "Congenital Valvular Obstruction of the Urethra", *Archives of Disease in Childhood*, Volume iv, 1929, page 255.

ACTINOMYCOSIS.

THE current issue introduces to our readers the first of a series of researches on human actinomycosis by Dr. S. Gardiner. In this article the author, who has had a unique experience of this disease and who perhaps has made a more exhaustive study of its nature than any living surgeon, deals with the disease as it affects the female genital tract. Further contributions on the disease as it affects various other regions will follow in future numbers of this journal. There can be no doubt that actinomycotic infection is relatively common in Australia, and that if surgeons are to avoid errors in diagnosis, which are nearly always due to the presence of secondary infection by pyogenic cocci, they must be continually on guard, and become what the author describes as "actinomycosis-minded". The writer has investigated the subject in all its aspects, including animal experimentation, and the literature of the whole world, comprising hundreds of articles in many journals unobtainable in this country, has been carefully collected and exhaustively studied. This research, essentially Australian, contains many original

observations and some entirely new conceptions as to the nature and behaviour of this interesting infection.

Dr. Gardiner has presented his collection of all the available literature on the subject, with translations, to the Royal Australasian College of Surgeons, and these, either in full or in précis form, will be available in the College Library for the use of any who may require them. This gift is an extremely valuable one, and it is hoped that it will be emulated in the future by others.

HAROLD R. DEW.

Surgery in Other Countries.

"PERCAINE" ANÆSTHESIA FOR OPERATIONS UPON THE STOMACH.

I. Philipowicz (Czernowitz), *Zentralblatt für Chirurgie*, May 5, 1934.

FOR the last two years Philipowicz has carried out a series of abdominal operations (about 50) under the anæsthesia obtained by means of a lavage of the peritoneal cavity with a 0·05% solution of "Percaine". Except in rare cases of extreme nervousness he has used it in all gastric operations.

The method employed is that of Baruch and Henschen, and recommended by von Mandl and others. It is as follows:

The patient receives a preliminary injection of a morphine derivative ("Pantopon") and atropine. The abdomen is opened by a paramedian incision after infiltration in two steps or layers with a 0·5% solution of "Neotonocaine"; a subaponeurotic infiltration of the peritoneum is carried out with the same solution. A small opening is made through the parietal peritoneum. Through this opening is introduced a small rubber tube, 10 centimetres in length, and containing a series of small lateral openings. The tube is attached to a 10 cubic centimetre syringe, and with this 20 cubic centimetres of 0·05% solution of "Percaine" are injected against the inner surface of the peritoneum underlying the parietal incision. After an interval of two minutes the peritoneum can be opened painlessly along the whole length of the incision. Another 20 cubic centimetres of the 0·05% solution of "Percaine" are now so injected as to flood the neighbouring peritoneum, mesocolon and omentum. The anæsthetic effect can be increased and more widely distributed by shaking the patient to and fro. Retractors are now introduced and by means of a 20 centimetres long tube three injections of 20 cubic centimetres each of the solution are injected at intervals of two minutes, the first into the left subphrenic space in the region of the portal fissure, the second into the *bursa omentalis* with the patient in Trendelenburg position, and the third against the spinal column after the transverse colon is raised. At the completion of these injections the patient is again shaken. Complete anæsthesia will be established after an interval of two minutes. One hundred cubic centimetres of "Percaine" solution have thus been employed, but, if necessary, this amount can be increased without risk up to 150 cubic centimetres (Henschen). Philipowicz does not exceed 80 to 100 cubic centimetres of the solution to commence with, but applies additional amounts to areas as required during progress of an operation.

Philipowicz describes the anæsthesia obtained as perfect. The strongest traction on stomach, duodenum, gall-bladder and colon, as well as resection of these organs, is borne without pain. In an operation extending over an hour and a half, Philipowicz does not hesitate to use additional amounts of the solution if necessary. He states that he has not seen any marked or alarming toxic effects of the "Percaine" solution. Pallor, fall of blood pressure and tachycardia have occurred, but under such conditions the patient has responded readily to the use of "Coramine" with caffeine or strychnine.

During convalescence, Philipowicz on three occasions has seen a marked intestinal stasis, which, however, yielded to the use of "Prostigmin" and hypertonic saline solution.

This method of anæsthesia may have a limited field in the badly debilitated and patients in whom for other reasons inhalation anæsthesia presents too great a danger. Philipowicz's series, however, seems much too small to elicit the possible

dangers of the method. It is known that other workers have had more alarming experiences, and death has occurred after flooding the peritoneum with "Percaine" solution, though it is believed that the solution used in that case was a stronger one.

B. T. ZWAR.

SACRAL FISTULA.

Professor Dr. D. Kulenkampff, "*Die Technik der Sacral fisteloperation*", *Der Chirurg*, September 15, 1934.

ACCORDING to the author, there are two difficulties: (i) the distinction of a sacral fistula from a fistula of the rectum, and (ii) the technique of the operation which is required for its treatment. The usual incision in the anal furrow does not heal well. Moreover, it does not allow a proper review of the tissue surrounding the fistula. The author makes a flap with the base cranially placed. As a rule, it will be found that the fistulous opening will be in the middle of the flap. If it should lie laterally or downwards towards the anus, an H-shaped incision can be made (see figure).
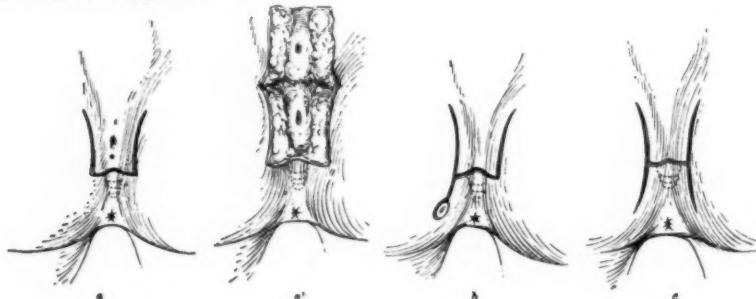
Kulenkampff had one case in which, after several unsuccessful operations, he was able to effect a cure by dissecting out the tip of the coccyx. A microscopic examination of the coccygeal tip revealed an epithelial proliferation which had penetrated the bone.

The details of the author's operation are as follows: Under local anæsthesia, incisions are made in the manner described (figure, *a*, *b*, *c*). In dissecting up this flap he keeps the knife close to the skin in the mid-line and away from it laterally, so as to leave a good deal of subcutaneous tissue on its lateral and scarcely any on the medial aspect. The fistulous track with the tissue surrounding it is then widely excised. The flap is replaced and fixed in position with a few sutures. The fistulous opening in the skin-flap serves as a small drainage opening. The flap lies snugly in the depth of the anal furrow, because in this situation it has very little subcutaneous tissue and it is therefore thin and pliant. Its lateral parts, on which a thick layer of fat has been left, help to fill up the defect.

H. B. DEVINE.

POST-OPERATIVE RELIEF OF THE STRAIN ON THE ABDOMINAL WALL OF A PATIENT IN THE DORSAL POSITION.

Fr. Schede (Leipzig), "*Entlastung der Bauchwand in Rückenlage*", *Zentralblatt für Chirurgie*, June, 1934.

SCHEDE points out that the abdominal wall of a man who lies on the back is, through the force of gravity, deformed in the same way as a tube seen in section or also as a water drop is deformed (see Figure 1). The weaker or the

more inactive the abdominal wall musculature, the greater is the deformity of the belly wall. The force of gravity can be broken up into a sagittal and a frontal component, the resultant of which is the line a in Figure 2; that is, the direction through which the weight of the belly wall acts when the patient is in the dorsal position. Operation incisions which cross this line tend to gape. The sutures in such wounds are on tension. In the same way, over-extension of the belly wall after confinement follows the direction of this line so long as the patient is lying down. Soon, when she stands up, the danger of "hanging belly" begins. It is clear that one can counteract relaxation of the belly wall
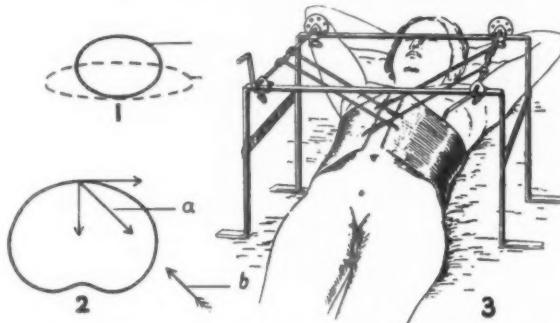
FIGURE 1. Cylindrical form with a stiff wall, and deformation through the force of gravity in the loose wall.

FIGURE 2. a. Resultant of the force of gravity. b. Opposing force.

FIGURE 3. Arrangement for supporting the belly wall.

after belly operations, and also after confinements, only through an opposing force which acts in the direction of the line. This cannot be done by using a sandbag. A sandbag really increases the action of the force of gravity. A soft bandage will cause the same deformity, as seen in Figure 1. In order to overcome the action of gravity a firm support which can lift the belly covering in the desired direction should be placed outside the body. The illustrated arrangement (Figure 3) is based on these considerations. Its efficacy was tested by the author on his own abdomen after an appendicectomy.

H. B. DEVINE.

Reviews.

BRAIN ABSCESS.

Abscess of the Brain: Its Pathology, Diagnosis and Treatment. By E. M. ATKINSON, M.B., B.S., F.R.C.S.; 1934. London: Medical Publications, Limited. Royal 8vo., pp. 299, with illustrations Price: 21s. net.

"ABSCESS OF THE BRAIN", by E. Miles Atkinson, is a monograph based upon the author's Jacksonian Prize Essay on this subject. Although necessarily based on a limited number of personal cases, and although the subject is dealt with almost entirely from the point of view of the otologist, any surgeon will find this book stimulating and instructive. The author points out the predominating

frequency of chronic *otitis media* as an ætiological factor in this lesion and pays a fine tribute to the surprising results obtained by Macewen. In this connexion there can be no doubt that the latter obtained such good results because his cases were of comparatively long standing. This in our opinion rather supports the arguments put forward by several recent authorities, who insist that the question in most cases of brain abscess is not how soon one can operate, but how long one can wait before operation, the idea being to allow adequate time to elapse for the formation of a reasonably firm wall to the abscess. It is interesting to find that the author, contrary to many other observers, holds the view that early operation is advisable.

The chapters on anatomy and physiology are illustrated by clear drawings, while the researches of Weed and others on the cerebro-spinal fluid are given due prominence. The chapters on the pathology of the lesion are admirable and the illustrations are good and convincing, while the problems associated with the mode of infection and extension are fully discussed. In his chapter on diagnosis, the writer emphasizes the importance of modern advances in neuro-surgery, the need for a more optimistic outlook, and the fact that many variations from the classical clinical picture occur, so that accurate diagnosis is, in spite of some assertions to the contrary, full of difficulties; he also emphasizes the necessity for co-operation with the neurologist if better results are to be obtained.

The risk of lumbar puncture is emphasized, but the author is a strong supporter of the value of ventricular puncture as a diagnostic aid. In his discussion of the various localizing signs he covers the ground in a concise manner and is particularly satisfying when dealing with the clinical aspect of cerebellar abscess.

When the vexed question of treatment is considered the author is a protagonist of early interference, and deals in a systematic way with all the well-known problems, such as the difficulty of finding the abscess, the risk of losing it, the route of approach and the best mode of drainage and management. Most of the modern methods of treatment are mentioned, although insufficient emphasis is laid on some of the more recent contributions in the literature. It is not surprising that the author favours otological methods of approach, but he advances good reasons for this advocacy. He condemns operation in two stages, deals with the exact method of obtaining drainage, being an advocate of the two-tube method, and rightly insists on the value, as Macewen found, of masterly inactivity during the post-operative period. The insistence on simplicity of methods, gentleness and avoidance of trauma are all in keeping with the principles of modern neurosurgical surgery.

Although there is nothing very new in this chapter, it is a very interesting one, and with the appendix, which contains records of case histories and a fairly full bibliography, rounds off a concise and well written monograph. The subject is one which, because of its difficulties, has always made an appeal to thinking surgeons, and this work is the most complete of its kind that we have read, so that it should be in the hands of all those who, from the nature of their practice, come in contact with this type of lesion.

DISEASES OF THE THROAT.

Modern Advances in Diseases of the Throat. By ARTHUR MILLER, F.R.C.S. (Edin.), D.L.O.; 1934. London: H. K. Lewis and Company, Limited. Medium 8vo., pp. 120, with 40 illustrations and one coloured plate. Price: 10s. 6d. net.

THIS is quite a valuable little book, and in a practical manner deals with an important branch of specialized surgery. Tonsillectomy is probably the most commonly performed of all operations, a fact which justifies the appearance of a book of this nature. The author's views are sound, reasonable and commendably conservative. The description of the anatomy of the tonsil is excellent,

giving information that is rarely found in a textbook. The author favours the operation of dissection for tonsillectomy performed with a Boyle-Davis gag. This has become now a more or less standardized method of operating. Complications after tonsillectomy are clearly and adequately discussed. Tonsillectomy with the hæmostatic guillotine is described and correctly criticized. As a fact this very crude instrument may be suitable for the gelder on the farm, but it is out of place in modern pharyngeal surgery on human beings. Methods of treating diseased tonsils by diathermy are described. The author strongly recommends the use of the La Force adenotome for removal of adenoids.

There are certain blemishes in this book which we feel obliged to mention. It is a melancholy fact that modern medical literature not seldom shows signs of hasty writing and of inadequate revision. The author frequently uses the words "tonsillectomized"—a vile word—and "non-tonsillectomized", which is outrageous. Such abbreviations as "hæm. strept." and "suitable" guttæ" should never have reached the printed page. The author is often careless in the construction of his sentences; for instance, on page 21 the sentence beginning "Some observers" is an amusing ambiguity. The penultimate paragraph on page 32 should be entirely rewritten. It may be mentioned that there is no such thing as a "logical step"— there may be a logical argument or reason. The author has an irritating habit of using capital letters incorrectly, the preface containing many examples of this. Also the over-use of italics misleads the reader by producing false impressions of emphasis. The reference on page 12 to Figure 19 is incorrect. Under the section of *atresia palati* the illustration and reference should read Denehy and Amies.

The book is beautifully produced in keeping with the usual high standard of the publishers. We favourably recommend it to all surgeons interested in diseases of the throat.

NON-MALIGNANT THIRD VENTRICLE TUMOURS.

Benign Tumours in the Third Ventricle of the Brain: Diagnosis and Treatment. By WALTER E. DANDY, M.D. 1934. London: Baillière, Tindall and Cox. Royal 8vo., pp. 171, with 120 illustrations. Price: 22s. 6d.

THE surgical aspect of intracranial tumours is a subject so wide that monographs on special regions of the brain or on particular aspects of a problem in relation to the brain, rather than comprehensive textbooks, have been the chief methods of dissemination of new information on this very important branch of modern surgery. Dandy's "Benign Tumours of the Third Ventricle of the Brain" is perhaps one of the most specialized of these monographs. It is based on a series of 21 cases operated on by himself. In addition to these, he has collected the records of 47 cases from literature. Dandy divides tumours of the third ventricle into two groups: colloid cysts, which are peculiar to this part of the brain; and a heterogeneous group which includes several different types, all of which he regards as benign because they are encapsuled. He includes in this collection cysts of the fifth ventricle—the space between the layers of the *septum pellucidum* —and also cysts of Verga's ventricle—the space between the psalterium of the fornix and the *corpus callosum*. He does not include tumours such as gliomata, craniopharyngiomata, pituitary and pineal tumours, which grow into the third ventricle.

Dandy points out that tumours of the third ventricle probably originate in early life, but as many of them are slow growing, they do not, especially in the case of colloid cysts, produce symptoms until after the age of twenty. Many of the miscellaneous groups, however, become apparent before this age. He lays special stress on the fact that, as there is no fixed syndrome, the diagnosis can rarely be made except by ventriculography.

He states that the most suggestive clinical features are evidence of a lesion in the region of the *corpora quadrigemina*: loss of pupillary reflex, bilateral ptosis and ophthalmoplegia, and also intermittent attacks of headache, dizziness,

bilateral sensory and motor disturbances, and loss of vision, all occurring on change of posture.

In five of Dandy's cases the diagnosis could be made by the X ray shadow of calcification. In his hands, the ventriculographic findings are pathognomonic.

Ventriculographic criteria owe their special characteristics to the blocking of the foramina of Monro, so that air injected into one lateral ventricle does not pass into the other and, in an antero-posterior radiograph, the median margin of the injected ventricle is seen to pass across the mid-line. He describes the exception to this. Dandy's results of operative treatment in tumours of the third ventricle have been extraordinarily good. Not only must his immediate results, his mortality of 33%, be considered very low for such an involved undertaking, but also his remote results, in the apparent permanence of cure and small occurrence of functional damage. For the removal of these tumours Dandy uses four recognized approaches to this region: (i) the pineal; (ii) the frontal, with removal of a cap of the frontal lobe; or (iii) frontal, with transection and retraction of the frontal lobe; and (iv) in the case of cysts of the *septum pellucidum* a mid-sagittal approach through the *corpus callosum*. The choice of route depends on the ventriculographic picture indicating the exact site of the tumour, and this is fully discussed and illustrated in the accounts of different cases.

Though the operative details will be of importance only to the few neurological surgeons, and invaluable to them, this book should find a place among the books of reference of every neurologist.

FRACTURES.

Fractures. By P. B. MAGNUSON, M.D.; 1933. Philadelphia: J. B. Lippincott Company. Australia: Angus and Robertson. Royal 8vo., pp. 486, with 317 illustrations. Price: 37s. 6d. net.

MAGNUSON'S book on fractures is set forth in the preface as being for "the man who first sees the fracture". It is a record of personal experience and personal methods, methods which the author has found satisfactory and which he now passes on without any blustering and didactic assumption that everyone else is wrong. As such it constitutes a valuable addition to the rather overwhelming literature that is accumulating on the subject, giving as it does the author's method of dealing with all the common fractures, with the surprising exception of Bennett's stave, or fracture of the base of the first metacarpal. There is, in addition, a chapter on physiotherapy, wherein both the uses and misuses of the various forms of such treatment are indicated.

Although the book bears the date 1933, modern means of treatment receive scant attention; thus there is no mention of Watson Jones's reduction and ambulatory treatment of spine fractures, nor of Böhler's screw traction methods of reducing fractures of the bones of the forearm and leg, nor of non-padded plaster casts. On the other hand, there are excellent articles on shoulder injuries, treated largely in what appears to be an efficient abduction splint (Cleary); on elbow fractures, and on fractures of the lateral tuberosity of the tibia. These last, which are becoming so common in our days of motor traffic problems, are reduced in a compression *redresseur*.

Operative treatment is put in its right place—it is described as a method to be used only by the expert when other methods have failed or are likely to fail, for example, in fracture of the neck of the femur, ununited fracture of the carpal navicular, fracture of the head of the radius, certain fractures of the radius and ulna *et cetera*.

In fractures of the spine with cord lesions the author advocates earlier operative interference, believing that in the presence of subarachnoid block as shown by Queckenstedt's test many useful lives and limbs may be saved by

laminectomy and exploration of the cord. He believes that a laminectomy does no harm, and that by waiting for cessation of improvement irreparable damage may be done.

PHYSIOLOGY.

A Short History of Physiology. By K. J. FRANKLIN; 1933. London: John Bale, Sons and Danielsson, Limited. Crown 8vo., pp. 122. Price: 3s. 6d. net.

IT might be anticipated that any attempt to compress into less than 120 pages the history of animal physiology from the sixth century B.C. to the end of the nineteenth century would be doomed to failure, because the result would be either a dry and wearisome catalogue of names or an incomplete and inadequate sketch. The fact that the present volume is neither of these reflects great credit upon the author's skill in the selection and arrangement of the landmarks of progress. He has produced a really useful and extremely readable book.

In the preface he has anticipated the criticism that he has devoted too much space to the period before Harvey, and has done so lest "the reader forget the slowness of progress in this period".

From Harvey onward he traces century by century the story of the development of physiology as an experimental science, the most important fresh advances being gathered together in the systems to which they belong. And so he goes on to the end of the nineteenth century, where he ends, leaving us with a strong impression of an unfinished story—an impression that the epilogue which briefly states Claude Bernard's notion of internal environment does not wholly dispel.

Such a feeling of incompleteness is fitting in any history of a progressive science, but an epilogue which indicated the general lines of advance in the present century would have formed a more fitting conclusion to this very attractive little book, which we warmly recommend to our readers.

OPHTHALMOLOGY.

A Short History of Ophthalmology. By A. SORSBY, M.D., F.R.C.S., with a foreword by R. R. JAMES, F.R.C.S.; 1933. London: John Bale, Sons and Danielsson, Limited. Crown 8vo., pp. 103, with illustrations. Price: 3s. 6d. net

"A SHORT HISTORY OF OPHTHALMOLOGY", by Arnold Sorsby, is a valuable contribution to the very limited amount of literature available in English on the history of ophthalmology Unfortunately, few of the foreign, especially the German, works on the subject have been translated. Mr. Sorsby has to his credit several papers on the history of ophthalmology in England and is well qualified for the task he has undertaken.

In the present work he gives a clear and most interesting account of the growth of ophthalmological science. Beginning with a brief account of the treatment of eye diseases during the Babylonian, Egyptian, Greek and Arabian periods and the Western Middle Ages, he traces separately the growth of knowledge of the anatomy, physiology and pathology of the eye, devotes chapters to cataract, glaucoma, therapeutics, spectacles and the ophthalmoscope, and concludes with a concise review of ophthalmology in the British Isles.

To neglect the study of the development of our science is to lose much of its scientific interest and to fail to realize the continuity of scientific development. Other men laboured that we might enjoy the fruits of their labours. The vast majority of those who benefit are unaware of the nature and extent of their obligations. The object of Mr. Sorsby's compact little volume—it runs to only one hundred pages, with eight illustrations and a helpful bibliography—is

to make us more conscious of our obligations to the great men of the past. Medical men generally will read it with interest. To ophthalmologists it will be an appetiser to whet the desire for a wider knowledge of the history of their specialty.

THE NERVOUS SYSTEM.

An Introduction to the Study of the Nervous System. By E. E. HEWER, D.Sc., and G. M. SANDES, M.B., B.S. (Second Edition); 1933. London: William Heinemann (Medical Books) Limited. Crown 4to, pp. 161, with illustrations. Price: 21s. net.

FIRST-CLASS textbooks on neurological anatomy and physiology are notoriously rare. The reason for this is not far to seek. We all have our feet on different rungs of the neurological ladder. A book for medical students is usually too elementary to be of great assistance to the practitioner; a book for graduates is neither sufficiently detailed nor advanced for the specialist in neurology.

Hewer and Sandes have attempted, not quite successfully, to cater for these three classes in the same volume. The diagrams are a prominent feature of the book, but many are extremely complex, and quite beyond the grasp of the average student mind. The text is well written and, for the reader who is able to take his medicine in tablet form, this book is admirable. Neurology, however, either in its anatomical, physiological or clinical aspects, is scarcely adapted to this method of concentrated teaching. And, because there would be a grave risk of permanently frightening him off an admittedly difficult though highly intellectual subject, we doubt the wisdom of placing this book into the hands of the undergraduate student. Of topical interest to surgeons in general is the chapter on the autonomic nervous system. After studying these eight pages operating surgeons cannot fail to increase their knowledge of this complicated subject.

The authors suggest that the bewildering variability of post-operative results may have an anatomico-physiological basis.

We recommend the book to candidates for the Primary Fellowship and for the M.R.C.P. examinations. This type of reader will derive much knowledge from it.

The printing and indexing are excellent, and a complete absence of misprints does great credit to the thoroughness and care of authors and publishers alike.

Editorial Notices.

The Australian and New Zealand Journal of Surgery

APRIL, 1935.

TABLE OF CONTENTS.

Message from His Majesty the King

Sandringham,
Norfolk.

It has given me much satisfaction to receive the loyal communication addressed to me by the Council and Fellows of the Royal Australasian College of Surgeons on the occasion of the opening of the new College building in Melbourne, and I would ask you to convey to them an expression of my cordial thanks.

Recognising as I do the benefits to be derived from cooperation between the Mother Country and the Dominions in the wide field of surgery, I am happy to think that this important ceremony is being performed today by the President of the Royal College of Surgeons in England, and I send my sincere good wishes for the welfare and prosperity of the College.

George R.I.

4th March, 1935.

THE OPENING OF THE COLLEGE.

On Monday, March 4, 1935, the building of the Royal Australasian College of Surgeons was officially opened. At 2.15 p.m., wearing academic dress, the Fellows of the College assembled on the lawns in front of the building. Sir Henry Newland, the President of the College, invited the President of the Royal College of Surgeons of England, Sir Holburt Waring, Bt., to open the building. Sir Holburt Waring then unlocked the building and declared it open.

Sir Holburt Waring read a message from His Majesty the King. This message is printed on a previous page.

Sir Holburt Waring delivered a short address. In the course of his remarks he said that he wished to congratulate the President and Council of the Royal Australasian College of Surgeons on the excellence of the site and the beauty of the grounds and surroundings in which their new building was situated, and also on the facilities afforded for future extensions. He also wished to congratulate the founders of the College on the great and rapid progress made since the foundation of the institution. In comparison with the progress made by the Royal College of Surgeons of England the rate of progress and development had been phenomenally rapid. The Royal Australasian College of Surgeons, however, had not been fettered by ancient traditions and charters or by an alliance with the barbers of Australasia. He complimented the Australasian College on its flexible constitution, since this would afford it greater scope for rapid advancement than was possible under the narrow constitutions of similar bodies in other portions of the British Empire. The present constitution of the College had been wisely drawn up. It gave the Council wide powers which would help materially in the early years of adolescence and advance to maturity. An organization fettered by ancient charters sometimes made progress with difficulty and occasionally found itself retarded and impeded in carrying out desirable and often necessary reforms. When the College had attained maturity and its aims and objects had become fully defined, then it might be desirable to proceed to obtain a Royal Charter from His Majesty the King.

The method of electing Fellows—a combination of curriculum, possession of a senior degree in surgery (including the previous passing of a higher examination in anatomy and physiology), and an examination and evaluation by a Board of Censors—was another matter of congratulation. It was wise to insist upon the possession of a senior university degree in surgery or a comparable diploma, since surgery was a science as well as an art. The science could be learned from books, but perfection in the art could be gained only by practice under a master.

The Royal Australasian College of Surgeons had a great destiny. As Sir Holburt Waring foresaw it, the College would carry on most important work for the Commonwealth of Australia and the Dominion of New Zealand. It was going to raise to a higher level the practice of surgery generally in both countries and also was going to help materially in the provision of a higher standard of accommodation, equipment and personnel in hospitals. He had little doubt that both Federal and State Ministries of Australia and the Dominion Ministry of New Zealand would come to the College for advice and help in the medical problems of legislation, including the provision of new hospitals and their design and equipment, and the appointment of their personnel.

The College would create a large central library of surgery and ancillary subjects which would be of incalculable value to research workers in surgery and biology, since progress in research in the subjects of surgery and biology could not be separated.

The existence of a large surgical and biological library would enable every research worker in these subjects to obtain the existing state of knowledge before embarking upon a specific line of intended research. In the past much valuable

time, energy and expense had been wasted by research students owing to neglect by them of ascertaining the existing condition of knowledge concerning their projected line of research. He could commend to all those wealthy donors interested in scientific surgical research the provision of funds for extension and equipment of the library of the Royal Australasian College of Surgeons, and for the building, equipment and endowment of a surgical research institute or farm.

Another important function which would devolve upon the Council of the College would be the organization and development of a centre of post-graduate education in surgery. He understood that arrangements were being made by the Council and the governing body of Prince Henry's Hospital for the establishment of such a centre. This would entail on the part of the governors of the hospital provision of extra accommodation for patients and the erection of new departments for radiology and pathology in order to make the establishment completely equipped for the investigation and treatment of patients by modern and up-to-date methods. On this, however, he would have much more to say at a later period of the meeting.

In conclusion he expressed the hope that the Royal Australasian College of Surgeons—root and branch—would continue to advance and progress in all its legitimate undertakings and flourish for ever.

Sir Henry Newland conveyed the thanks of the President and Council of the Royal Australasian College of Surgeons to Sir Holburt Waring. He also thanked the Premier of the State of Victoria, Sir Stanley Argyle, K.B.E., for the grant of land on which the College building stood.

Sir Stanley Argyle replied and at the conclusion of his remarks he named the gardens surrounding the College building the "College Gardens".

Sir D'Arcy Power read a paper entitled "How Surgery Came to Australasia". This paper is published at page 368.

HONORARY FELLOWSHIPS.

At the inaugural meeting on Monday, March 4, at the Wilson Hall, in the presence of His Excellency the Lieutenant Governor of Victoria, Sir William Irvine, Honorary Fellowships were conferred on the following:

> Sir Holburt Jacob Waring, Bt.
> Sir D'Arcy Power, K.B.E.
> Henry Wade, C.M.G.
> Donald Church Balfour.
> Edward William Archibald.
> John Fraser, M.C.
> Dean Lewis.
> Charles Frederick Morris Saint, C.B.E.
> Frederick Wood Jones.

An Honorary Fellowship of the Royal College of Surgeons of Edinburgh was conferred on the President, Sir Henry Newland, by Mr. Henry Wade, C.M.G., on behalf of the Royal College of Surgeons of Edinburgh.

GREETINGS FROM OVERSEAS.

At the inaugural meeting on Monday, March 4, 1935, a message was received from the Royal College of Surgeons of England. This message was delivered by Sir Holburt Waring. A replica of the document is reproduced on page 342. Dr. Henry Wade read a message from the Royal College of Surgeons of Edinburgh; this message is reproduced on page 343. A message of greeting and goodwill from the President and Regents of the American College of Surgeons was read by Dr. Donald Balfour, President-Elect of the American College of Surgeons. Professor E. W. Archibald, of the McGill University, Canada, read a message from the Royal College of Physicians and Surgeons of Canada.

We the Council of the Royal College of Surgeons of England at our meeting in London on January the tenth 1935 have the honour to entrust to the hands of our President Sir Holburt Waring on the eve of his departure for Australia, a message of greeting to the Royal Australasian College of Surgeons

We desire to express our pride that the President has been chosen to open ceremonially the new house of the Royal Australasian College, and our satisfaction that this fresh personal relation between the two Colleges has been added to those of a common citizenship, culture and tradition.

On this happy occasion we wish especially to convey to the Australasian College our heartiest good wishes on its entry into its new home and for its prosperity therein. In conclusion and with deep sincerity we would congratulate the College on the accomplishment of another step towards the fulfilment of the illustrious destiny promised by the high ideals of its founders.

Holburt Waring — President

Wilfred Trotter
Arthur H. Burgess. } Vice Presidents

Ernest W. Hey Groves
R. G. Hogarth
R. H. Kelly
Robt. a. m. Simpson
J. J. A. Steward
A. James Walton
C. H. Fagge
R. S. Watt Johnson
H. Lampson Handley
Gordon Watson
Geo. E. Gask
R. C. Elmslie
Victor Bonney
L. R. Braithwaite
G. Cecil Inverness
W. S. Pratt
Ernest O. Gange

P. Philip Ball

January 10th 1935.

The PRESIDENT and FELLOWS
OF THE
Royal College of Surgeons of Edinburgh
offer their warmest congratulations to the
PRESIDENT and FELLOWS
OF THE
Royal Australasian College of Surgeons
on the inauguration of the future home of their College

As the oldest Medical Corporation in the British Empire, the Royal College of Surgeons of Edinburgh, now in her four hundred and thirtieth year, extends the hand of friendship to her Sister College in Australasia and welcomes the prospect of her sharing in the task of fostering and maintaining, among those who practise the art of surgery, the highest standards of service to the community and the honour and dignity of their profession.

The Royal College of Surgeons of Edinburgh cordially thanks the Royal Australasian College of Surgeons for the welcome extended to its delegate and is confident that the friendship thus happily inaugurated will lead to close co-operation between the two Colleges in their common sphere of action and will help to strengthen the link which already unites the Edinburgh Medical School with the Medical Schools of Australasia.

The President and Fellows of the Royal College of Surgeons of Edinburgh, at their meeting on February, 5th 1935, conferred, with acclamation, the Honorary Fellowship of the College on the President of the Royal Australasian College of Surgeons and have the honour to ask the President to accept the Diploma of Honorary Fellowship at the hands of their delegate Mr Henry Wade.

Arthur Henry Havens Sinclair President.

Edinburgh, 6th February, 1935.

The opening of the College Building. The entrance of Fellows after the doors had been unlocked by Sir Holburt Waring.
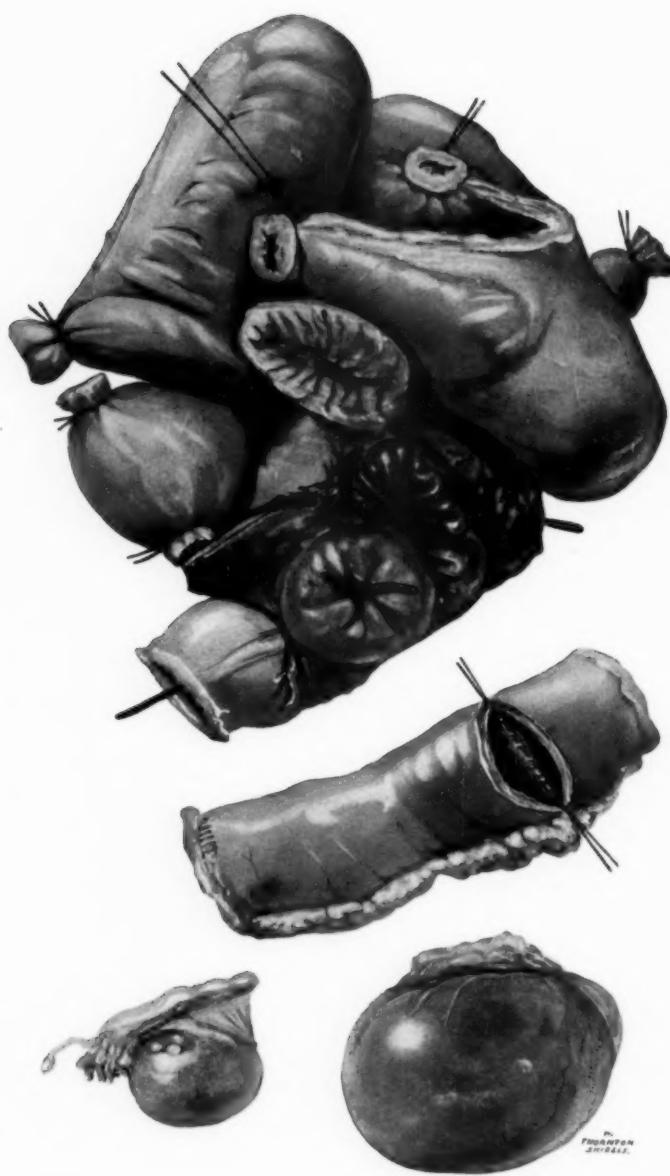
FIGURE I. Case I. Specimen removed at my first and the patient's second operation. The small separate portion of intestine depicted below was extirpated to reduce the number of anastomoses required. Two ovarian cysts removed at same operation.